Insects Close Up

INSECTS CLOSE UP

A Pictorial Guide for the Photographer and Collector

by EDWARD S. ROSS

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by EDWARD S. ROSS · *A Pictorial Guide for the Photographer and Collector Featuring 125 Photographs and Drawings*

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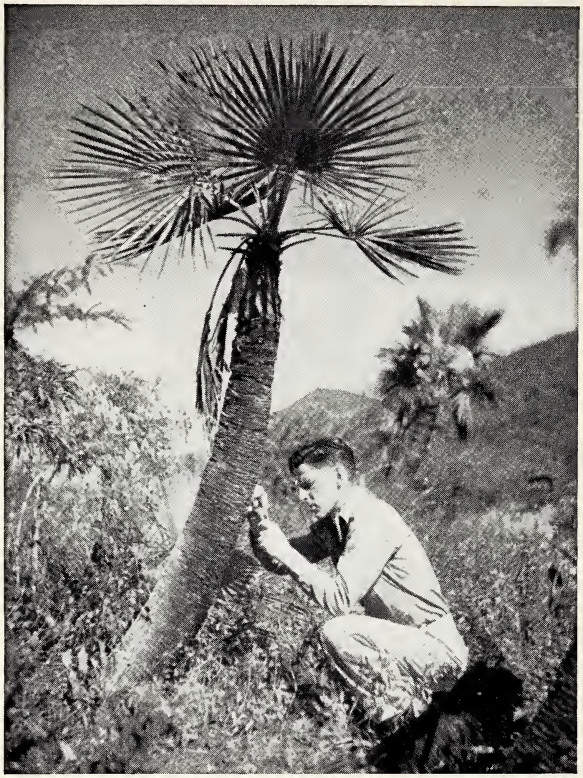
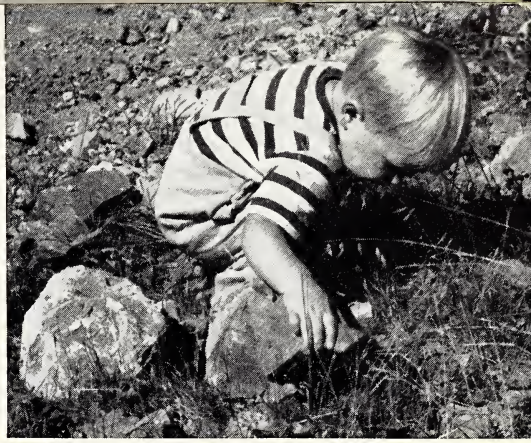


Photograph by F. E. Skinner

The author, who is now Curator of Entomology at the California Academy of Sciences, never quite outgrew his boyhood curiosity about small living things. He is shown here collecting the first known specimens of a wonderful new genus and species of web spinner (see page 15). The scene is southern Mexico. The insects were found in their silken galleries on the bark of the palmetto.

Close to Nature



Peeking under stones and showing great curiosity about all sorts of small crawling or hopping things, this little boy is responding normally to the marvels of the world into which he was so recently born. His is a happy period of life — a time when everything is new and wonderful — and literally he is close enough to nature to notice even its smallest details.

Those who can retain this kind of youthful enthusiasm and curiosity as their eyes move up and away from the soil are very likely to live rich and happy lives. As one gains the wisdom and resources that should come with maturity, one is able to take up a natural history hobby or a scientific career. Such activities lead to adventures in learning unknown to those who consume precious time with commonplace activities.

Our world is full of interesting things to study, observe, collect, or photograph. Among the kinds of living things, the insects, constituting a populous three-fourths of the total, offer an almost limitless source of intellectual pleasure. The following pages, with their pictures and brief sketches, are presented as a kind of showcase of the "wares" of the insect world. Of necessity the display is very limited and full of omissions but I trust that it is sufficient to stimulate you to take up, or intensify, some hobby involving insects or related forms of life.

Regardless of the type of entomological hobby you select, it is vital for you to have a broad view of the insect world. The best way of gaining this is by making a collection, and for this reason I have given the necessary technique considerable space in the how-to-do-it section of this book. These instructions should serve to start you off, but other books will be needed to perfect your methods and to identify your specimens as they accumulate. A number of such books are cited in the Recommended References at the end of this book.

To those interested in photography, I submit these pictures as samples of the many picture-taking opportunities afforded by the insects of any field or yard. Hunting small living things with a camera has proved to be a most exciting experience to me, one full of the thrill of the unexpected and very instructive as to the habits of the subjects. Unless otherwise stated, all of these were living, unposed individuals whose normal activities were disturbed as little as possible by my actions. The technique used in capturing the often elusive insect on film is outlined on the concluding pages of this book. The kind of equipment used in taking each picture has been given in the accompanying legend for the convenience of the photographer.

Plant bug on tarweed

Insects' Viewpoint

Look at this picture, and those that follow, from the viewpoint of a small insect. In this one the tarweed leaf surface is a weird meadow of glistening glandular hairs which scent the warm, humid air with aromatic oil. The tiny plant bug, though only three-sixteenths of an inch in length, looms up like a great stilted monster—a harmless creature though, interested only in sucking plant juices through its long, jointed beak.

You soon become aware of many dangers in this strange world. Bulgy-eyed spiders might lurk over the horizon of the curved leaf. A hawk-like fly could snatch you up in a spiny embrace and stab you with its sharp beak while in flight to a distant perch. A cyclonic stirring of the air might be your last worldly sensation before being swallowed by a bird.

Study this complex miniature world and learn how insects manage to meet the problems of survival.

Subject: *Lygus convexicollis* (Stål). Order Hemiptera, family Miridae.
Photo data: Exakta VX with Novoflex bellows and Heiland Strobonar flash.

Air Supremacy Past and Present

This perched dragonfly exhibits the great rounded eyes that enable its kind to see and catch small insects in flight. Eyes of its distant ancestors saw the world millions of years ago in the Carboniferous period before there were any warm-blooded animals. The main vertebrates were amphibians. None of the reptiles that had recently appeared on earth had as yet taken to the air, nor were there any birds or bats. Fossils from this early period indicate that insects were the only flying animals and that huge dragonflies—some with nearly thirty inches of wing spread—must have ruled the sky over jungles of giant ferns, horsetails, and cycads.

Except for size, many of our modern dragonflies are quite similar to these ancient giants. One might assume that the large primitive kinds were unable to avoid attack as the vertebrates evolved and perfected powers of flight. With this challenge to the dragonfly's air superiority, a reduction of size with increased maneuverability was in order. Our fleet, smaller, modern kinds now have little to fear from attack by winged foe.

Subject: *Tarnetrum corruptum* (Hagen). Order Odonata, family Libellulidae. **5**
Photo data: Exakta VX with Heiland Strobonar flash, living but posed.

Portrait of a dragonfly

Grasshoppers

Grasshoppers serve as food for many kinds of animals, especially birds and reptiles. In certain regions even man seeks the grasshopper to satisfy his appetite. Like all edible animals, these insects have evolved special ways of avoiding their hungry enemies. Anyone who has tried to catch a grasshopper soon learns that among the best of these ways is a sudden, unpredictable leap that is often greatly extended by flight.

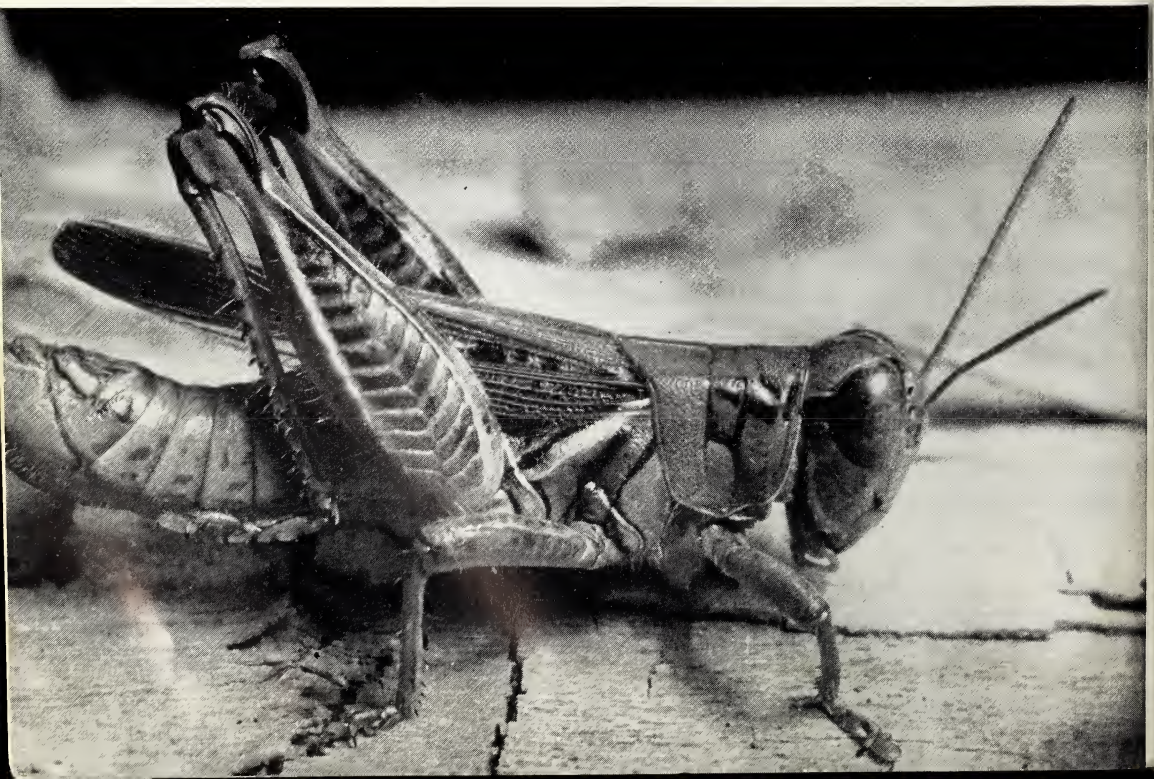
In the picture below we see a grasshopper, alerted by the approaching lens, making ready for such an escape. In this preparation grasshoppers lift their hind "feet" (tarsi) to gain additional thrust. A sudden snap of the legs, powered by huge muscles contained in the chevron-marked, thick hind femora, slaps these feet against the opposing surface and sends the hopper aloft as though jet-propelled.

Numerous in kind, diverse in form and color, grasshoppers should be very popular subjects for the insect collector. Unfortunately, very few hobbyists have ever discovered this. As a result, the grasshoppers of many regions are very poorly known.

Subject: *Melanoplus devastator* Scudder, male. Order Orthoptera, family Acrididae.

Photo data: Hasselblad with Heiland Strobonar flash.

Grasshopper preparing to leap



Grasshopper laying eggs

A Grasshopper Hides Her Eggs

Almost all grasshoppers lay their eggs in the soil. One day I caught this one in the act, crawled up very close, and took her picture.

The egg-laying organs at the tip of the female's abdomen do the digging. They are very hard and have saw-toothed edges to make them effective soil drills. As they go deeper and deeper into the soil the abdomen becomes greatly elongated. Scientists believe that air pressure causes this stretching and stiffening.

When the hole is ready, the female secretes a foamy substance from the tip of her abdomen. Then, depending on the species, she deposits from two to a hundred tiny cigar-shaped eggs. Later the foam hardens to form a protective shell around the egg mass.

After a period the eggs hatch, that is, if they have escaped the notice of the many parasites that thrive on such masses. Young grasshoppers are miniature but almost perfect copies of their parents. As they eat and grow, they pass through five stages, each marked by the shedding of a skin. This youngster (right) has probably just shed a skin; when it eats, its abdomen will become much longer.

Subject: *Trimerotropis coeruleipes* Scudder. Order Orthoptera, family Acrididae.

Photo data: Exakta VX with Strobonar flash (upper, a converted Kodachrome).

Young grasshopper

Green as Grass

In addition to leaping, grasshoppers escape their enemies by means of camouflage. This may involve coloration that blends with that of the surroundings, as shown by this leaf-green species. This foliage matching is very common among all sorts of insects which normally live in green meadows or in other vegetation. The green pigment often results from a diet of fresh leaves rich in chlorophyll.

Equally striking examples of protective coloration are to be seen among the grasshoppers and other insects that live among dry grass, fallen leaves, or on bare earth or rock. Through natural selection the blending with specific ground colors and textures, such as those of granite sand or reddish loam, may be very close indeed. Besides color and pattern, the camouflage may also involve body shape and surface sculpture. Thus, on the exposed ground of arid regions of the world, there are grasshoppers that closely resemble pebbles.

Grasshoppers usually have wings. The front wings are always narrow with environment-matching coloration while the hind wings, which are the main organs of flight, are large and fan-like. They are often brightly colored and surprise one as they are suddenly displayed in flight.

Other grasshoppers, like the one pictured here, have only small, functionless wing pads that resemble those of immature normally winged species. Still other kinds, especially those inhabiting deserts, have absolutely no trace of wings.

Subject: *Melanoplus marginatus* (Scudder), female. Order Orthoptera, family Acrididae.

Photo data: Exakta VX with Heiland Strobonar flash.

This grasshopper is almost invisible in its green world

Katydid eating at night

Katydids

By flashlight I focused my camera on this katydid as it chewed away on a hazelnut leaf. Electronic flash made possible a color photograph at night.

Katydids are related to grasshoppers and show it in their leaping-type hind legs. They can be distinguished, however, by their exceedingly long, many-segmented antennae. The chirping song of the males (the female is silent) is a familiar sound of late summer and fall evenings.

Like the grasshopper, opposite, katydids that live on taller vegetation closely resemble leaves. Such camouflage must cause them to be frequently overlooked by many an insect-eating enemy.

The reddish blade-like structure on the tail of this individual shows that it is a female. This organ is used for laying eggs in a most remarkable manner. It deftly slits the edges of leaves and neatly deposits rows of flat eggs between the two leaf surfaces.

The development of katydids is much like that of grasshoppers. A group of youngsters—brothers and sisters from the same batch of eggs—tend to stay together on the same plant. They are readily reared in cages in the manner one cares for caterpillars of moths and butterflies.

Subject: *Scudderia furcata* Brunner. Order Orthoptera, family Tettigoniidae.
Photo Data: Hasselblad with Heiland Strobonar flash.

Jerusalem Cricket

In appearance the ponderous Jerusalem cricket is a far cry from the slender green katydid of the preceding page, yet the two are related. In a sense this kind of "cricket" is merely a katydid adapted to life on the ground or underground. For its particular way of life, wings, leaping-type legs, and leaf-like coloration and form are inappropriate.

It depends for survival on great strength, powerful jaws, and the confining of its foraging to the protective darkness of night. During the day these crickets hide under stones or other objects. Even if they could risk being seen in daylight, it is likely that they would be very uncomfortable because their pigmentation appears to be too pale to block the sun's harmful rays.

In spite of all, they are not immune to attack. As they wander about at night they are seen by nocturnal animals. Even bats will swoop down like hawks and eat them. The frequency of cricket body parts in the stomachs of dissected pallid bats (p. 28) supports this conclusion. When attacked, the crickets turn on their backs, kick their spiny legs, and snap wicked jaws at the attacker.

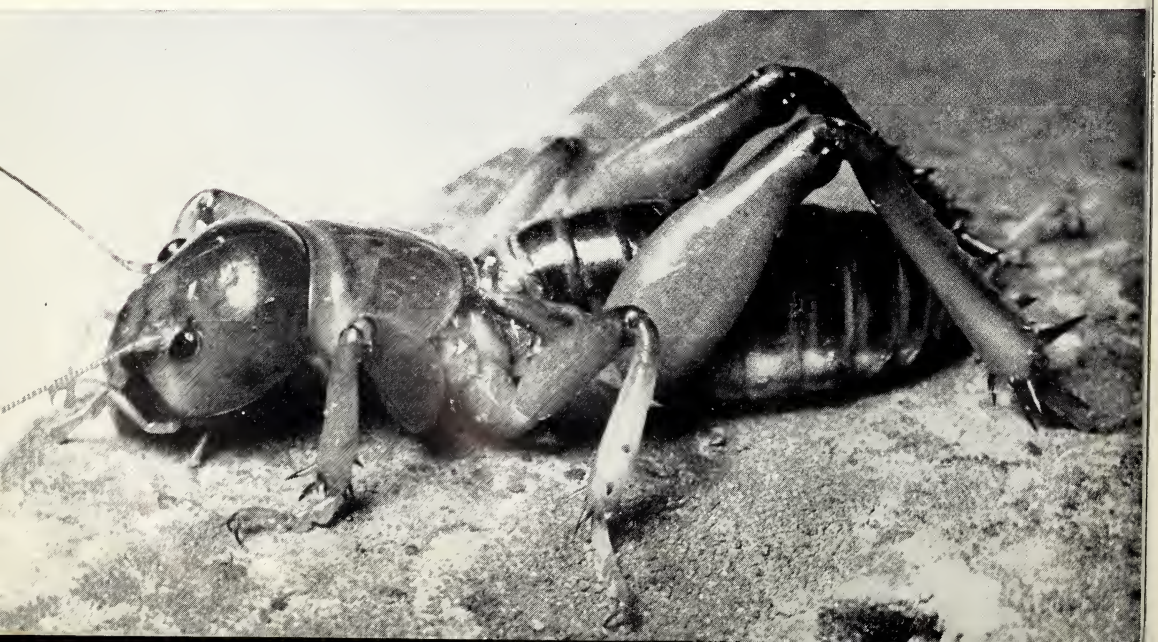
The crickets eat roots and tubers as well as insects. At times they are even cannibalistic.

Why they are called Jerusalem crickets is a mystery to me—at least it is a better name than "potato bug," which is so often applied.

Subject: *Stenopelmatus longispina* Brunner. Order Orthoptera, family Tettigoniidae.

Photo data: Hasselblad with Heiland Strobonar flash.

A Jerusalem cricket is really a kind of katydid



Have you ever met a eumastacid?

Rare hopper

This inquisitive long-legged hopper is a member of one of the least-known families of grasshoppers. The ten species of this family, the Eumastacidae, occurring within our borders, are confined to the southwestern states. In general, this family is restricted to warm or tropical regions, where the species live in trees and shrubs. The one pictured here is found in the dense brush of hot California hillsides. Both sexes are entirely wingless and hold their hind legs in this curious widespread position.

I know of one scientist who traveled across the continent to study members of this family. I happen to live on the side of the very mountain our figured species is named after. Consequently, I wasn't at all surprised one day to have one of its kind hop into my living room when the door was left open.

You may not have eumastacids in your region, but certainly you have one or more equally choice insect species that occasionally make it the Mecca of an insect hunter.

Subject: *Morsea californica tamalpaisensis* Rehn and Hebard, male. Order Orthoptera, family Eumastacidae.

Photo data: Exakta VX with Strobonar flash.

Eumastacid surveying its arboreal world

Praying mantis scratching its head

Nature's Parallels—Mantis and Mantispa

On these facing pages we have an excellent example of convergent development in structure—the occurrence of similar body parts in entirely unrelated forms of life.

Above, we see the peculiar grappling front legs of the praying mantis, a member of the order containing such insects as grasshoppers, crickets, and cockroaches. Opposite, we note almost identical legs in *Mantispa,* a member of a very distinct group, the one which contains "nerve-winged" insects like the ant lion and lacewing (pages 36 and 37). In each case the legs function much like spring traps that catch and securely hold struggling prey while it is eaten alive.

This mantis, by the way, is a tan, short-winged female (the males have long wings) of a western species. There are many kinds of these hunting insects in the world. In form and coloration, they tend to resemble foliage, twigs, bark, or, as in this case, the ground litter.

Subject: *Litaneutria obscura* Scudder. Order Orthoptera, family Mantidae.

Photo data: Exakta VX with Strobonar flash.

The eyes of death

***Mantispa,* a kind of lacewing, closely resembles a wasp**

Below, *Mantispa* the neuropteron, uses her mantis-like front legs to hold the remnants of a spider she has just eaten. Like the mantis, she neatly folds her legs while awaiting the next victim to come within reach.

As evident in the above picture, this species is almost identical in form and coloration to certain paper wasps (*Polistes*). This must reflect some biological interrelationship with these wasps that remains to be investigated. Most *Mantispa* larvae eat spider egg masses and moth pupae. Still others have been found living in the paper nests of wasps (Polybiinae).

Subject: *Mantispa brunnea occidentalis* Banks. Order Neuroptera, family Mantispidae.

Photo data: Exakta VX with Heiland Strobonar flash.

Mantispas use their front legs for holding prey

A male earwig has large pincers

The Etymology and Entomology of the Earwig

The significance of the name "earwig" for the above insect has been the subject of much discussion. Some say it refers to the insect's ear-shaped hind wings; others believe it is associated with the resemblance of the tail pincers to the tool used for piercing ear lobes for earrings. I favor the opinion that the name has something to do with the entrance of the insects into the ear openings.

Earwig is a very old name derived from the Anglo-Saxon word *earwicga* (*eare* = ear + *wicga* = beetle, worm). When the name first developed, the habitat of both the earwig and human beings was almost one and the same. The Anglo-Saxons lived in sod or stone huts with thatched roofs and earthen floors and probably slept on piles of hay or skins on the floor. Especially during winter months, these abodes must have also housed many insects including earwigs.

Earwigs instinctively hide in small crevices and cavities. The ear openings of a heavily slumbering person pillowed in straw could well have been an inviting hide-out for these insects. A special name for an insect causing such discomfort must have early appeared in the language.

The most pestiferous earwig in this country is not native. It is the same European species that must have crawled into the ears of the Anglo-Saxons. Introduced here by man, and constantly extending its range, this earwig is quite a nuisance in certain regions. It eats many types of food. Plant food of high protein content, such as flower parts and pollen, is preferred. Insects are also eaten, with a preference for aphis and scale insects. The common objection to earwigs is their mere presence in flowers, corn, and other layered plant parts.

The function of the pincers on the tail end is not well understood. It is likely that they are weapons of defense.

Subject: *Forficula auricularia* L. Order Dermaptera, family Forficulidae.
Photo data: Hasselblad with Heiland Strobonar flash.

Halls of Silk

The most remarkable thing about these insects, the embiids, is that both young and adults are able to spin silk with their front feet. Each foot contains scores of silk glands that supply special hollow spinning hairs. With rapid strokes that resemble the actions of a shadow boxer, they can quickly spin walls of delicate silk to form a complex system of tunnels in which many individuals may live together in harmony.

These tunnels are usually spun on the surface of bark or under stones in warm regions of the world. The food is any sort of dead vegetable material. When a spider or other enemy is encountered, an embiid escapes by darting backward. It has special large "reverse" muscles in the thick hind legs to motivate this backward movement. The cerci at the tail end of the body are very sensitive to touch and probably serve as "eyes" to guide the otherwise blind retreat.

Only adult male embiids have wings, and these could be quite a hindrance to running backward if they weren't flexible and reversible when at rest over the back (see below). The wings are made rigid for flight by blood pressure in a hollow vein that runs the length of each wing.

Subject: *Pararhagadochir trachelia* (Navás). Order Embioptera, family Embiidae.

Photo data: Hasselblad with Strobonar flash.

Female embiid in its silk tunnel

Wings reverse when males run backward

"Child of the Earth"

Niña de la tierra—child of the earth— is said to be the name that Mexican Indians give this insect, the Jerusalem cricket, which I discussed on page 10.

The great dome-shaped head suggests a human cranium, and it is easy to see why the insect should excite the wonder and superstition reflected in its Spanish name.

To an entomologist, the gigantic head means space to accommodate big muscles that move the large reddish brown jaws. Edges of these jaws can be seen on either side of the disc-shaped upper lip, or labrum. The slender, jointed appendages nearby are called palpi. Their tips probably have food-tasting and touch functions. Like the jaws, they are vestiges of the pairs of legs that once occurred on every body segment of the ancient ancestors of insects. A number of forward body segments have fused, or joined together, to form the insect head. The pair of legs of each of these segments have changed to make up the multiple mouth parts.

Compare this portrait with those of the bug on page 25 and the butterfly on page 48. The head of the cricket is very simple in comparison.

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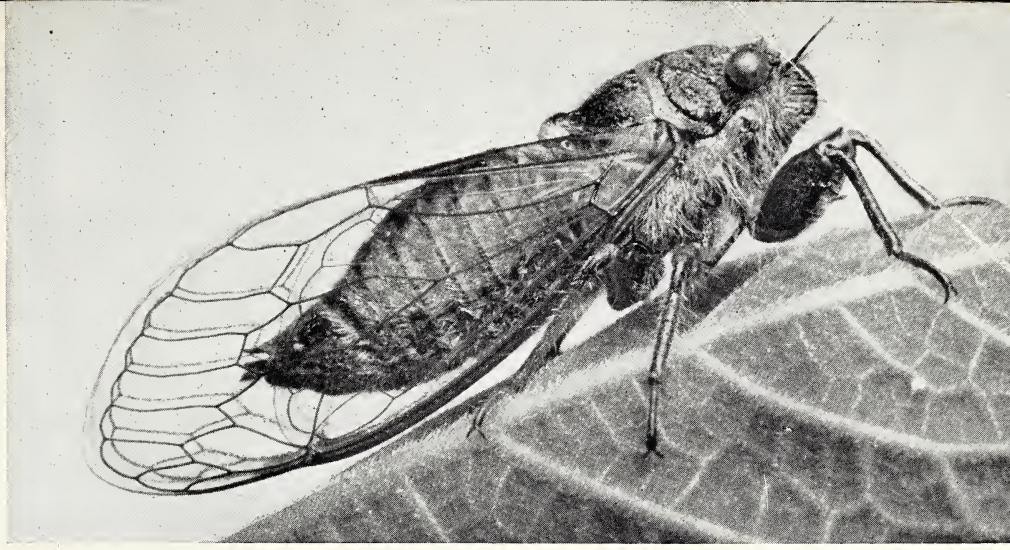
Subject: *Stenopelmatus longispina* Brunner. Order Orthoptera, family Tettigoniidae.

Photo data: Exakta VX with Heiland Strobonar flash.

Jerusalem cricket



Adult cicada

Cicadas

A familiar sound on a hot spring or summer day is the high-pitched whining of cicadas. Although most sing more like high-tension wires than insects, a great many make rasping or clicking noises. As in most insects, the ability to sing is limited to males. Special sound-producing organs located on the belly of males are absent in females. Both sexes are able to hear, and it is probable that the male's song aids a rendezvous for mating.

Cicadas are the most conspicuous members of the large group of plant-juice-sucking insects, the Homoptera. This group includes those pictured on the next two pages as well as aphis, scale insects, and leafhoppers.

The eggs of cicadas are tucked in slits in the bark of twigs. Tiny grub-like nymphs hatch from these, fall to the ground, and spend the rest of their lives as much as three feet below the surface. They suck juices from the roots of trees and shrubs. After a very lengthy period of development, one that may be as long as seventeen years (seventeen-year locust), the nymphs crawl out of the ground and onto various objects so that the adults can emerge. They tend to come out in definite broods, and numerous empty nymphal shells (right) are commonly seen still clinging to the site of the remarkable transformation.

Subject: *Platypedia areolata* Uhler (female and nymphal shell). Order Homoptera, family Cicadidae.

Photo data: Hasselblad with Strobonar flash.

Skins of cicada nymphs are a common sight

Empty nymphal skin of a treehopper

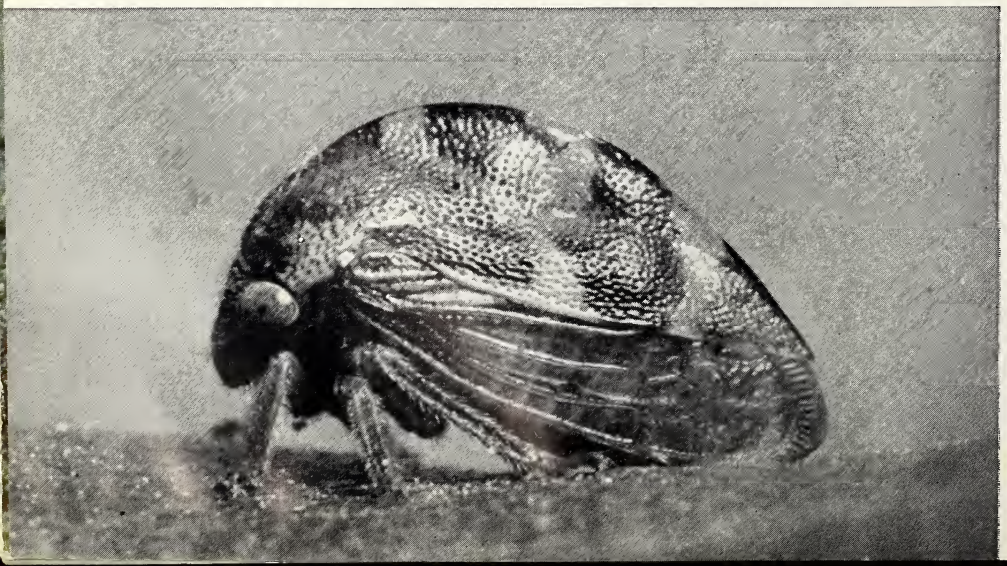
Ghost of Its Former Self

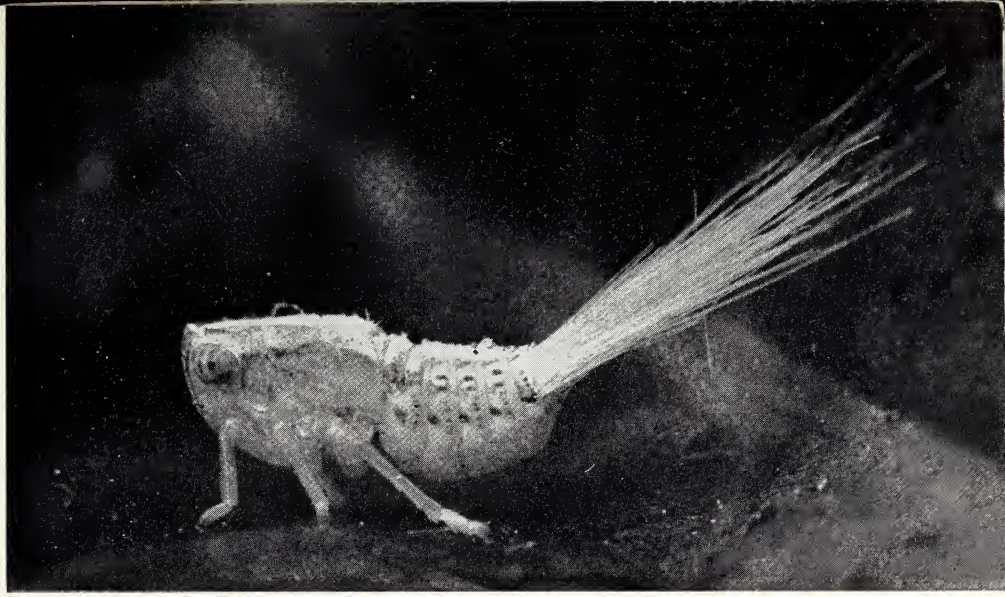
Look closely on leaves and twigs and occasionally you will see the empty skins of insects—stiff, white, ghost-like shells gently vibrating in the breeze. From the strange shell, pictured above, a teardrop-shaped adult treehopper (below) emerged. This adult probably represents the simplest form of this group. Other kinds are noted for their great horns and protuberances that cause them to resemble thorns, ants, and other things in their surroundings.

All insects grow in a series of stages, or instars, which are definite in number. Each is marked by a shedding of a skin that had become too confining for future growth.

Subject: *Cyrtolobus vanduzeei* (Godg.). Order Homoptera, family Membracidae.
Photo data: Exakta VX with Heiland Strobonar flash. About 16 X.

Adult treehopper





This fulgorid nymph has a false tail

Before and After

It often takes an experienced eye to correlate a mature insect with an individual of one of its early stages of development. This is well shown in the two sets of pictures on these facing pages.

The chalky-white creature with the brushy tail gives little hint that it will soon become the net-winged fulgorid shown below. The remarkable tail actually isn't a part of the body. It is merely a bundle of wax filaments extruded from special pores clustered at the tail end. Essentially it is the same substance that makes a mealybug mealy or that composes the shell of a scale insect. This false tail is very brittle and breaks at the slightest touch.

Subject: *Naethus vitripennis* (Stål). Order Homoptera, family Fulgoridae.
Photo data: Exakta VX with Heiland Strobonar flash. About 16 X.

The adult fulgorid is very little like its nymph

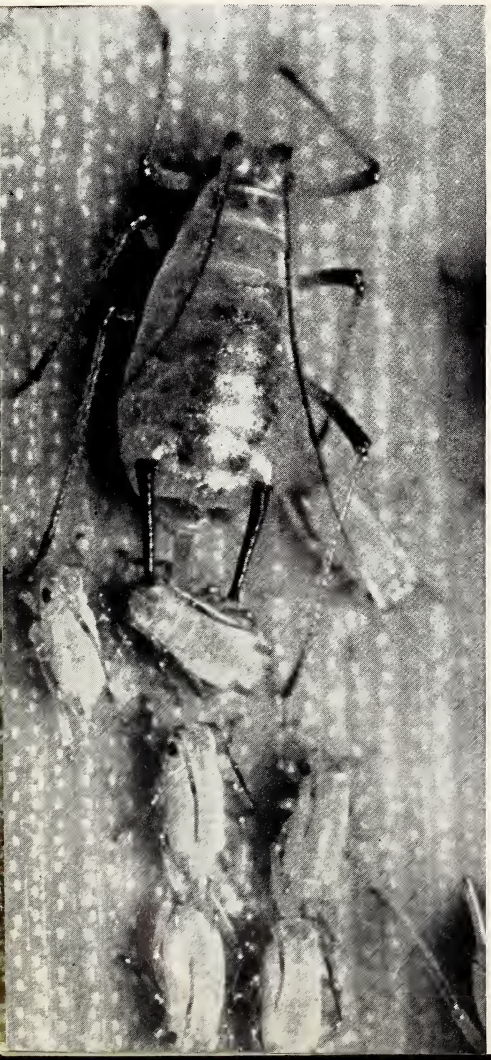
Plant Lice

No book on insects would be complete without a few words about aphis or plant lice. They are so numerous in kind and varied in way of life, however, that it is impossible to do justice to them in a small space.

All aphis suck plant juices, and as a rule each species prefers a particular kind of host plant. This preference may radically change, however, during the life cycle of a given species of aphis. For example, individuals may live part of the year on plum trees, then migrate to water lilies for the balance of the year.

Not only are aphis directly injurious to their plant host but they may also spread serious plant virus diseases.

The excess fluids and sugars sucked from the plant are constantly excreted as droplets of honeydew. These fluids are often consumed by other insects, especially ants. The honeydew also coats the foliage and causes the growth of a highly objectionable black smut fungus.



Aphis have a great many enemies, against which they offer little or no resistance. For example, a ladybird larva or adult may be seen chewing up an aphis while its neighbor appears unconcerned by the fact that it is next in line for the jaws of death. Aphis as a group owe their success not to the survival of individuals but to their high rate of reproduction. Depending on the species and period in the life cycle, young can be produced with or without mating. At times eggs are laid, but most species give birth to live young as in higher animals. Mature forms may be winged or wingless, depending on the species.

Pictured here on part of a grass blade is a mother grain aphis with her brood of babies, a few of the hundreds she will produce if she survives. Those black tubes near her tail are wax-secreting organs called cornicles.

Subject: *Macrosiphum granarium* (Kirby). Order Homoptera, family Aphididae.

Photo data: Exakta VX with Novoflex bellows and Heiland Strobonar flash.

Mother aphis and her young

A white fly passes a toad's nose

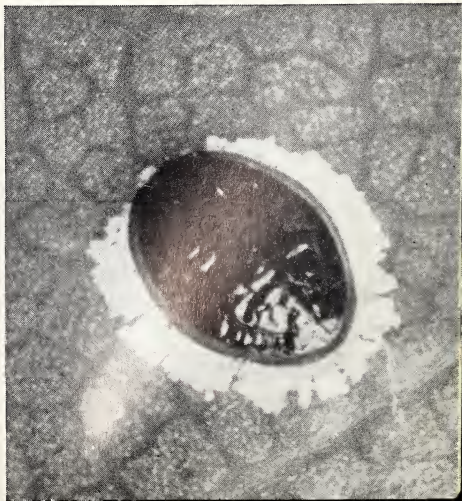
White Flies

After I took this toad's picture, I was pleased to discover that I had unknowingly photographed a white fly in mid-air just to the left of the toad's nose. What picture could better demonstrate the small size of the members of the family Aleyrodidae?

These so-called white flies are related to the aphis. The adults, shaped like tiny moths, are generally white and finely covered with powdery wax. They hide under leaves and are familiar to most gardeners, for when the plant they are on is shaken, small clouds of the insects fly up.

The young have habits and appearance suggesting the scale insects. Their flattened, circular form is usually outlined with a lacy white wax secretion.

Subject: *Trialeurodes vaporariorum* (Westw.) adult, *Tetraleurodes stanfordi* (Bemis) nymph. Order Homoptera, family Aleyrodidae.
Photo data: Exakta VX with Strobonar flash.



White fly nymphs are fixed to leaf surfaces

Ambush bug catching a wasp

They Lie in Ambush

On these facing pages, we see two entirely unrelated animals securing their food in the same manner. Above is *Phymata,* the ambush bug, catching a sand wasp; opposite, a crab spider has caught a bee fly. Each of these owes its success to being invisible in the flower while patiently waiting for some nectar-seeking insect to blunder within reach.

The ambush bug exhibits two principles of camouflage: first, an irregular body outline; and second, scattered color pattern that blends with the lights and shadows of its flower background. The crab spider depends largely on color, which over a period of days can change to match that of the background flower.

The reach of the ambush bug is short but powerful. The front legs are like grappling hooks capable of securely holding prey. Between meals of insect juices it may suck the nectar of flowers.

Subject: *Phymata* sp. Order Hemiptera, family Phymatidae.

Photo data: Exakta VX with Strobonar flash.

Ambush bugs are almost invisible in a flower

Crab spider catching a flower-visiting fly

Unlike so many spiders, the crab spider spins no silken web to snare its meal but, like *Phymata,* merely waits in flowers where the insect traffic is always great.

In common with web-spinning spiders, the eyes of crab spiders are tiny and probably of little value in seeing things. Some spiders, however, like the wolf spider and the cute, stubby, jumping spiders (below), have the front pair of eyes so greatly developed as to appear like headlights. These spiders weave no net of silk nor do they lie in ambush. They run about here and there in a constant search for food, depending on powerful eyes for their success.

Subjects: (upper) *Xysticus* sp. Order Araneida, family Thomisidae; (lower) family Salticidae.
Photo data: Exakta VX with Strobonar flash.

Jumping spiders have big front eyes

Cone-nose bug sucking blood from a hand

Bloodthirsty Cone-nose

This inch-long Mexican cone-nose bug (*Triatoma*) sucked blood from my left hand while my right operated the camera. Contrary to what might be expected, I experienced no pain or sensation of any sort as the hair-like stylets contained in the jointed beak (opposite) penetrated my flesh. As a matter of fact, I wouldn't have been at all aware that the bug was rapidly swelling itself with my blood had its attack occurred in the darkness of night, the time when these bugs normally feed.

The painless, delicate nature of this blood stealing is very important from the standpoint of the survival of the species. Should so large a bug inflict an irritating bite it would be quickly brushed off by the host. It would thus fail to get the blood meals necessary for its own development or that of the eggs within the body of the female. In the long course of their evolution it thus appears that these bugs have undergone selection for less and less sensation in their bite.

The success of *Triatoma* is unfortunate, however, for persons living in certain areas of tropical America because various species can spread a serious infection called Chagas' disease. This disease is related to African sleeping sickness because in both cases the germs involved are tiny one-celled animals called trypanosomes. When a bug feeds on a person or animal infected with these micro-organisms, it is able to spread them to uninfected individuals for the rest of its life. The trypanosomes are not injected during the bug's bite but enter the victim's body when he rubs the bug's fecal fluids into his eyes or mucous surfaces. The bugs appear invariably to defecate as they secure each fresh blood meal.

In the United States trypanosomes have been found in the blood of wood rats and other animals living near the Mexican border. Although no Chagas' disease (trypanosomiasis) has been reported within our borders among humans, scientists are closely studying the possibilities. One medical aspect of *Triatoma* bites does occur here, however. Repeated bites may cause a severe body reaction due to hypersensitivity.

In common with bedbugs and certain bat parasites, the triatomas are the only true bugs (order Hemiptera) that habitually feed on warm-blooded animals. The great majority of bugs suck plant fluids or that of other insects. Certain members of the family of cone-noses (Reduviidae), to which *Triatoma* belongs, and which normally prey on insects, will bite man in self-defense and their bites can cause severe pain.

Subject: *Triatoma phillosoma pallidipennis* (Stål). Order Hemiptera, family Reduviidae.

Photo data: Hasselblad with Heiland Strobonar flash, both pages.

Only hair-like stylets penetrate the skin. This beak is but a sheath.

Strange Bedfellows

The bedbug's long and intimate association with man seems to have begun in Eurasia many thousands of years ago. This was when our ancestors lived in caves—places that are usually occupied by bats and swallows, the preferred hosts of the fifty or so kinds of bedbugs known to science. In the long course of our evolution, we probably lived for a greater period of time in such natural abodes than in those of artificial construction. One species of bedbug, *Cimex lectularius,* pictured opposite, must have had plenty of time to transfer from a bat or swallow host and develop a preference for the blood of man.

Secretively feeding by night and retreating by day into nearby cracks and crevices to digest its blood meal, the bedbug has stayed by the side of man through the "thick and thin" of his rise in civilization. Another kind, the tropical bedbug, seems to have followed a parallel course in the warm regions.

Before feeding, these brown bugs are quite flat, or even concave, but after painlessly inserting their hair-like mouthparts into the flesh, they rapidly swell with blood and expose the smooth, shining, free-sliding portion of each abdominal plate. The bite affects people in a variety of ways. Quite often the irritation and desire to scratch do not appear until a day or more after the bite. As in the case of any blood-sucking insect, bedbugs are of medical interest for, potentially at least, they are capable of spreading disease.

Bedbugs like to live in groups in their hide-outs. Here the eggs are laid in clusters. The babies, miniature and paler copies of their parents, go out in the manner of adults on blood-sucking forays.

In spite of its beetle-like appearance, the bedbug is a member of the same order as the ambush bugs, stink bugs, and cone-noses (see pp. 22 and 24). Its sucking mouthparts clearly reveal this, for beetles have jaws for chewing. The hind wings, present in most true bugs, are reduced to almost nothing and the front wings are but short pads.

Bedbugs aren't inconvenienced by their inability to fly, for they accept the transportation provided by man. Safe in their hiding places in our furniture and other belongings, they are able to move wherever these things are transported. It is quite likely, therefore, that the lowly bedbug landed on Plymouth Rock in the Pilgrims' baggage.

Crowded life in cities is particularly favorable to the development of large bedbug populations. Fortunately, modern chemicals for controlling insects, especially DDT to which bedbugs are particularly susceptible, are getting the best of this problem.

Subject: *Cimex lectularius* L. Order Hemiptera, family Cimicidae.
Photo data: Exakta VX with Heiland Strobonar flash.

A bedbug begins to swell with blood

In a few moments the bug is fully fed

Bat in flight

Out on a Bat for the Night

When a bat flits across the night sky you see far more than a strange flying mammal—you see the host of a great variety of peculiar parasites. These include mites, ticks, rare bugs, unusual louse-like flies, and strange fleas. Each particular kind is found nowhere else in nature but in the dense fur of bats. All suck blood and must constantly irritate the bats. It is interesting that almost all of the parasites are wingless and completely dependent on their host for aerial transportation. The parasitic insects, however, have evolved from winged ancestors, but long ago most of them lost their organs of flight.

With the dawn the bats return, passengers and all, to resting places in buildings, caves, or crevices. Here they are attacked by still other parasites—special bedbugs which, instead of remaining in the fur, retreat to adjacent cracks and crevices following each blood meal.

Subject: Pacific pallid bat. *Antrozous pallidus pacificus* (Merriam). Order Chiroptera, family Vespertilionidae.

Photo data: Hasselblad with Strobonar flash. Flying specimen in room.

Hanging bats are attacked by bedbugs

Bat Passengers

These two parasites from the fur of bats have many features in common but they belong to widely separated orders of insects. One (left) is a polyctenid, a true bug (order Hemiptera), somewhat related to the bedbug. The other (right) is a bat tick fly, a very unusual member of the order composed of two-winged flies. In their resemblance, these insects exhibit the tendency of unrelated animals living in similar environments to develop parallel means of meeting the problems of survival. Porpoises, whales, and penguins—seagoing mammals and birds which have developed fish-like bodies and appendages—are familiar examples of this phenomenon.

The polyctenid bugs are very rare insects. So far, less than a hundred specimens have ever been collected. They live only in the fur of free-tail bats and thus would not be found on the pallid bat pictured opposite.

The bat tick fly belongs to a small family, the members of which are always long-legged and wingless. They are much more common than the polyctenids. A related family of bat flies, the Streblidae, have wings and short legs.

Bats also have their own special fleas but, strangely, they are not attacked by the lice that infest so many other mammals.

Subjects: (left) *Hesperoctenes eumops* Ferris and Usinger. Order Hemiptera, family Polyctenidae. (right) *Basilia antrozoi* (Townsend). Order Diptera, family Nycteribiidae. Both mounted on microscope slides.

Photo data: Hasselblad with bellows extension and Microtessar lens. Direct photography without microscope.

Bats are hosts to these strange parasitic insects

Tiger beetles are very alert

Tiger Beetle

Whether one's intentions are those of a collector or of a photographer, tiger beetles of the above kind are among the most unapproachable of insects. They sprint away or take wing in a flash of action. It took hours of stalking on hands and knees to get this picture.

Ever-alert and all-seeing, these beetles play the role of saber-toothed tiger in the insect community of the sandy shores or other flat, open places they constantly patrol. Their prey—usually some other insect—suffers sudden death when it falls into the grip of the sickle-shaped jaws.

The tiger beetle shown here is of the most common type, one that often exhibits beautiful metallic colors. They are sun-loving creatures that become inactive with the slightest unfavorable change in the weather.

In certain parts of the world there are black or dull-colored species that cannot fly and do their hunting at night. In tropical forests other kinds live up in the trees and forage for food in the manner of large ants. In New Guinea forests individuals of this kind played hide and seek with me as they dashed to the side of the tree trunk opposite from whatever direction I approached.

Subject: *Cicindela oregona* Leconte. Order Coleoptera, family Cicindelidae.
Photo data: Exakta VX with Heiland Strobonar flash.

Young Tiger

Can you image how it would feel to have a monster suddenly rise out of a hole and grasp you with a pair of great trap-like jaws? Something like this happens when an insect ventures near a tiger beetle larva sitting at the top of its burrow.

These larvae are grotesque, beady-eyed, earth-bound creatures that move elevator-fashion up and down in neatly excavated circular shafts in the ground (lower). The broad head and earth-caked prothorax together form a hard and effective plug to the burrow opening. In part this may serve to bar the entrance of parasites as well as predators interested in the tender, whitish after-body. The chief function, however, must be ambush. With the head and prothorax flush with the surface, the larva patiently lies in wait for some unsuspecting small creature to walk right across, or near, its lid-like head. With each close approach, the larva strikes out with wide-spread jaws in a partial back somersault and snatches the prey. Dorsally directed fangs and eyes on the top of the head aid the effectiveness of the attack.

The larva's strongly humped back helps to hold it up in a position to strike. Barb-like spines on the hump, which can hook into the burrow wall, tend to prevent it from being unwillingly pulled out of its lair by the resistance of an uncooperative victim. At the slightest sign of danger the larva can relax the hump's grip and drop like a stone to the bottom of the burrow.

Subject: *Omus californicus* Esch. Order Coleoptera, family Cicindelidae. Living specimen in artificial laboratory burrow.

Photo data: Hasselblad with Strobonar flash.

Tiger beetle larvae live in burrows

Tiger beetle burrow openings

Males of *Sinodendron* have horned heads

Rhinoceros in a Log

This little rhinoceros-like beetle that lives in the rotting wood of alder, ash, and willow along the Pacific coast of North America is one of the three species of its genus (*Sinodendron*) known in the world. Of the other two, one is European, the other lives in the Caspian region of Asia. Thus we have here an example of the many animals that indicate a close biological reationship between our Pacific coast fauna and that of Eurasia.

Most members of its family have the jaws greatly developed in the male, but those of *Sinodendron* are small. As though to make up for this, a great horn is produced on the top of its head, and the prothorax is flattened like the blade of a bulldozer. The female has no such horn, and its body is rounded at both ends.

A good reason for these differences is shown in the remarkable habits of these beetles. The male and female coöperate in providing for the future welfare of their larvae—truly a rare thing in insects. Both work together in making burrows in the rotting wood and in packing them with food in the form of wood fibers. The male's flattened front is far more effective than that of its mate in burrowing and pushing the fibers.

The female lays one or more eggs, which develop as C-shaped, wood-eating, white grubs (lower) that closely resemble those of a related family, the scarabs.

Subject: *Sinodendron rugosum* Mann. (Length, ½ inch). Order Coleoptera, family Lucanidae.

Photo data: Hasselblad with Heiland Strobonar flash.

***Sinodendron* grub in alder log**

Aphis-eye view of a ladybird beetle

Gardener's Ally

This monstrous-appearing beetle confronting us is nothing more than our tiny friend, the common ladybird beetle. I was able to snap its picture as it paused to free itself from the strand of spider's silk it had just blundered into. This view must be much like that seen by many a small insect a fleeting instant before its doom.

Not only do the adult ladybird beetles account for a lot of our pests, but we are likewise indebted to their dragon-like larvae which have the large appetites so characteristic of youngsters of all species.

Subject: *Hippodamia convergens* Guer. Order Coleoptera, family Coccinellidae.
Photo data: Exakta VX with Heiland Strobonar flash.

Stylops are strange parasitic beetles

34 Stylops Finds Its Mate

The tiny, white-winged, black-bodied creature on the abdomen of this wild bee has just found its mate. It is a male *Stylops*, a member of one of the strangest of insect orders—the Streptsiptera. This order is composed of highly specialized parasites that are believed to have evolved from beetle ancestors.

The female *Stylops* is scarcely more than a reproductive sac inserted in the host bee's abdomen (two are pictured, left). All we can see of each is a little brownish lobe—a mere vestige of the head and thorax. It has no legs, wings, or eyes, in fact very little that characterizes an insect. Its abdomen forever remains in that of the bee.

Two female *Stylops* in abdomen of bee

The male, however, is a very active and complicated insect. It emerged from a pupa that protruded from the abdomen of another bee. During its very short life it does nothing but seek a mate. Streptsiptera males are very rarely seen even by scientists, and I believe that these are the first photographs of living males ever made. Their very small size

can be judged in relation to the club-like anthers of the buttercup flower that the host bee visits.

Examine the male and you will see its strange, stalked eyes. The pair of narrow lobes that jut out behind these are vestiges of forewings, the equivalents of the wing cases of typical beetles. Most conspicuous are the broad, crinkly, fan-shaped hind wings that beat so rapidly in flight.

Now that the female has mated, her eggs will soon mature and hatch within her body as tiny, louse-like, primary larvae. In the heat of the sun these will crawl out onto the surface of the host bee. As the bee goes from flower to flower some of the crawlers are rubbed off, and they are then in a position to attach themselves to uninfested bees and be transported to their nests (holes in the ground).

In the nest chambers the primary larvae of the *Stylops* burrow into the bee's pollen- and nectar-fed, maggot-like larvae, shed their skins, and become legless grubs. Bathed in the body fluids of the developing bee, each young parasite absorbs nourishment through its thin skin. Vital tissues of the host are seldom seriously damaged, and the host eventually matures with one or more *Stylops* pupae protruding from its abdomen. The males emerge, fly off, mate, and thereby make possible a repetition of the strange cycle.

Bees are not the only insects plagued by Streptsiptera, which also infest ants, wasps, leafhoppers, true bugs (Hemiptera), and crickets.

Subject: *Stylops pacifica* Bohart, family Stylopidae. Order Streptsiptera. Bee host: *Andrena complexa* Vier. (immobilized). *Stylops* handling technique by Dr. J. W. MacSwain, University of California.

Photo data: Exakta VX with Novoflex extension and Heiland Strobonar flash.

Male *Stylops* mating with parasitic female in bee's abdomen

Larva of ant lion (on microscope slide)

Ant lion pit

Lion in the Dust

The slender, grayish adult of the ant lion, with its beautifully veined, glistening wings, gives little hint that its larval past was that of a sinister, merciless killer. The larva is earth-colored and lives in the bottom of a funnel-shaped pit it excavates in the sand or dust. It lies completely buried except for its ever-ready sickle-shaped jaws. When an ant or other insect starts to slide down the loose 45° slope of the funnel's side, the larva or doodle bug, as it is often named, flips its head to throw sand at the doomed victim to encourage its downfall on the crest of a miniature avalanche. Once in the waiting jaws, the prey's body fluids are quickly consumed and the empty carcass is cast aside.

The picture of the larva (left) is from a microscope slide preparation. It shows how scientists can study an insect's every detail by treating it with chemicals (p. 71) so that the skin can be emptied of internal organs.

Subject: *Hesperoleon papago* (Currie). Order Neuroptera, family Myrmelionidae.

Photo data: Exakta II with Thriftlite flash (adult). Larva — Hasselblad and Microtessar lens and Strobonar flash (direct photography without microscope).

Adult ant Lion

Aphis are the favorite food of lacewings

Lacewing

Almost every garden or field has its share of lacewings. The most familiar of these beneficial insects are entirely green in color with golden eyes—hence the generic name *Chrysopa.* Less familiar is this more brownish kind with larger wing cells appearing like the panes of a greenhouse roof. Our picture brings out the micro-pattern and delicate colors of the body as well as the rainbow luster of the wing membranes.

The larvae of these insects are much like those of the ant lion (opposite) but, instead of living in pits, they roam here and there over leaf and twig in search of living insect prey—chiefly aphis. They have a curious habit of collecting trash in the form of the emptied carcasses of their prey and other debris, which they mat together and carry over their back like the shell of a turtle. The first instinct of a newly hatched larva is to secure such a protective cover, not to seek a meal.

The eggs are remarkable in that they are borne on slender stalks of often considerable length. Eggs of the green lacewing are usually long-stalked and clustered. What I take to be the egg of the species pictured here is laid singly on a short stalk. This one is attached to the tip of a leaf spine.

Subject: *Eremochrysa* sp. Order Neuroptera, family Chrysopidae.
Photo data: Exakta VX with Strobonar flash.

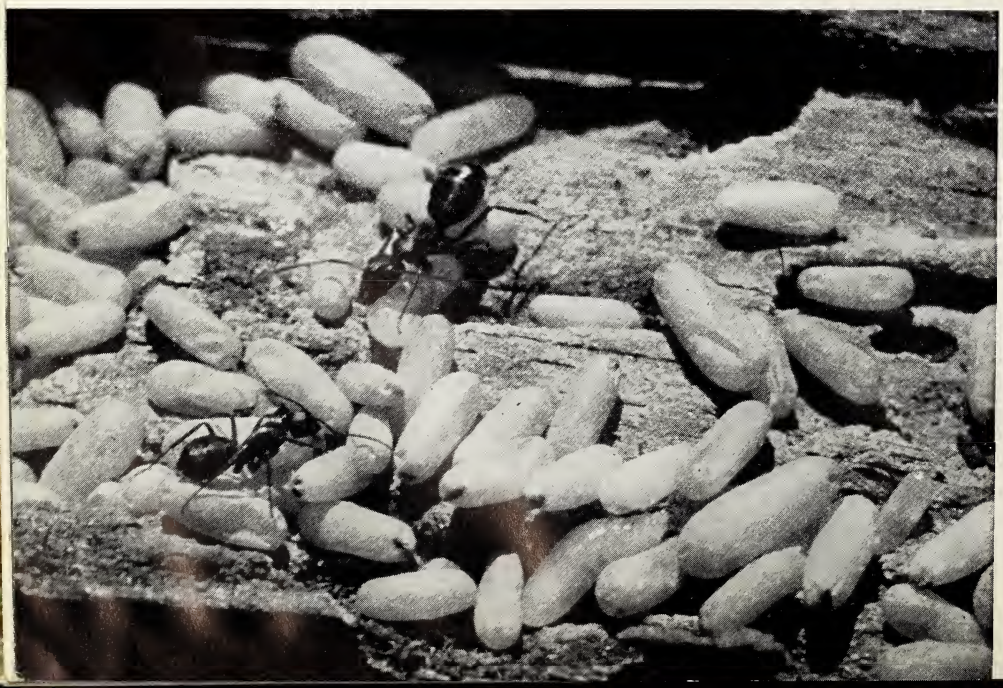
Lacewing eggs are stalked

Ant-hill Society

These ants (opposite) are not fighting. They are doing something far more interesting than that. The worker ant on the left, having been successful in its search for food, is passing a share of it to the mouth of a less fortunate member of its colony. Thus, in this rare picture we see in action the remarkable food-exchange habit which is essential to the development of complex and successful modern ant societies. This habit is one of the reasons why a single queen can produce literally thousands of helpless young yet scarcely needs to lift a tarsus to care for them.

In a typical ant colony, as in a community of humans, there are a great many different jobs to be done. In some ants these labors are divided among specialists. These comprise such castes as those of reproducers, soldiers, and workers. Some individuals may seldom, if ever, see the outside world and thus have little or no contact with food sources. They remain in the nest and take care of such chores as feeding the grub-like larvae, nest building, and transporting eggs, larvae, and pupae (as pictured below). These toilers in the dark are therefore often completely dependent on the mouth-to-mouth feeding instinct of the more worldly foraging members of the colony for their own food as well as that which they pass on to hundreds of waiting larvae. This giving is not so one-sided, however, for the larvae exude a delectable fluid which is like candy to ants.

Carpenter ants with their larvae and cocoons



Ants exchanging food

A strange refinement of mouth-to-mouth feeding occurs in the nests of some of the kinds of ants that feed on honeydew and other sweet liquids. The foragers feed certain fellow workers to near-bursting capacity. Their abdomens swell up like well-blown toy balloons. In effect, they become living storage bottles—a handy source of food for the whole colony during periods of poor food supply. Such periods are common in arid regions, where this habit flourishes.

One cannot leave the subject of mouth-to-mouth feeding without mentioning that it is what makes possible ant control by means of poisonous syrups. The syrup is passed throughout the colony, killing adults and young alike.

Another interesting sidelight is that many other insects take advantage of the ants by stealing food from their mouths. Some of these are guests that normally live in the nests. Others intercept the ants along their trails. Most unusual of these highjackers are tiny tropical mosquitoes (*Harpagomyia*) that appear to secure their food in no other way!

These are but a few glimpses into the many remarkable habits of ants. The nearly four thousand kinds of ants in the world do more strange things than could ever be conceived by a writer of fiction.

Subjects: *Camponotus* sp. (left) and *Formica* sp. (above). Order Hymenoptera, family Formicidae.

Photo data: (Left) Exakta II with Thriftlite flash, (above) Exakta VX with Heiland Strobonar flash.

Caterpillar Hunter

The nest of this graceful orange and black wasp is a deep circular hole in well-packed sand. She digs this by backing out many times, clutching sand between her front legs and fringed "chin." Each load is flown off a short distance and jettisoned in midair so that no pile of thrown-out sand will signal the location of the burrow's opening to the wasp's many insect enemies. Opposite, we see a wasp descending helicopter-fashion from one of these sand-transporting missions.

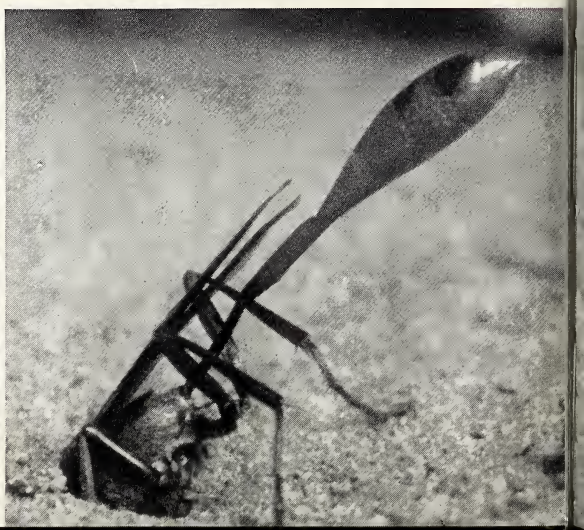
When the burrow-excavating job is completed, the wasp wanders about and collects a number of small pebbles just big enough to clog the opening of the hole. Dropped into place, these prevent the protective cover of sand, which is then scratched over the hole, from filling it. With this security complete, the wasp flies off in search of a caterpillar to provision the burrow with food for her unborn larva.

When found, the caterpillar is immobilized by stings in each of its many segments. The great length of the wasp's abdomen might well be an adaptation for distributing stings the full length of such elongated prey. The subdued caterpillar is laboriously dragged back to the concealed burrow, which is reopened for insertion of the caterpillar, then closed again so that the hunt can be repeated. This may go on four or five times. Finally the wasp lays an egg in this abundant food supply laid away for the larva to come.

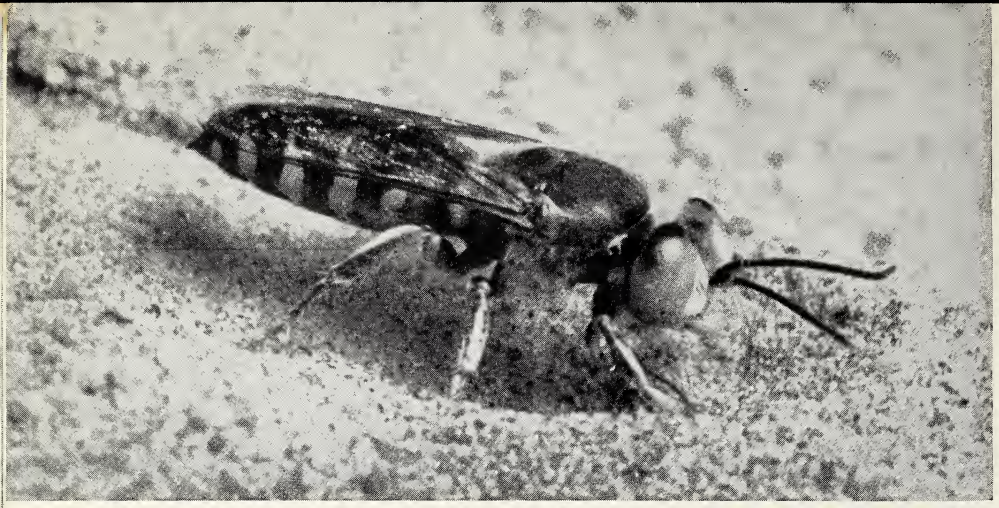
The wasp finally caves in the burrow by biting at its walls, and more sand is scraped in until it is completely filled. Then a most remarkable thing happens. In her mandibles the wasp picks up a pebble and with it very deliberately pounds the sand fill until it is firmly packed. By such an act this kind of wasp has the distinction of being one of the very few animals besides man that makes use of a tool.

Subject: *Sphex* sp. Order Hymenoptera, family Sphecidae.
Photo data (both pages): Exakta VX with Heiland Strobonar flash.

Digging a burrow in sandy soil



Caterpillar hunter comes in for a landing



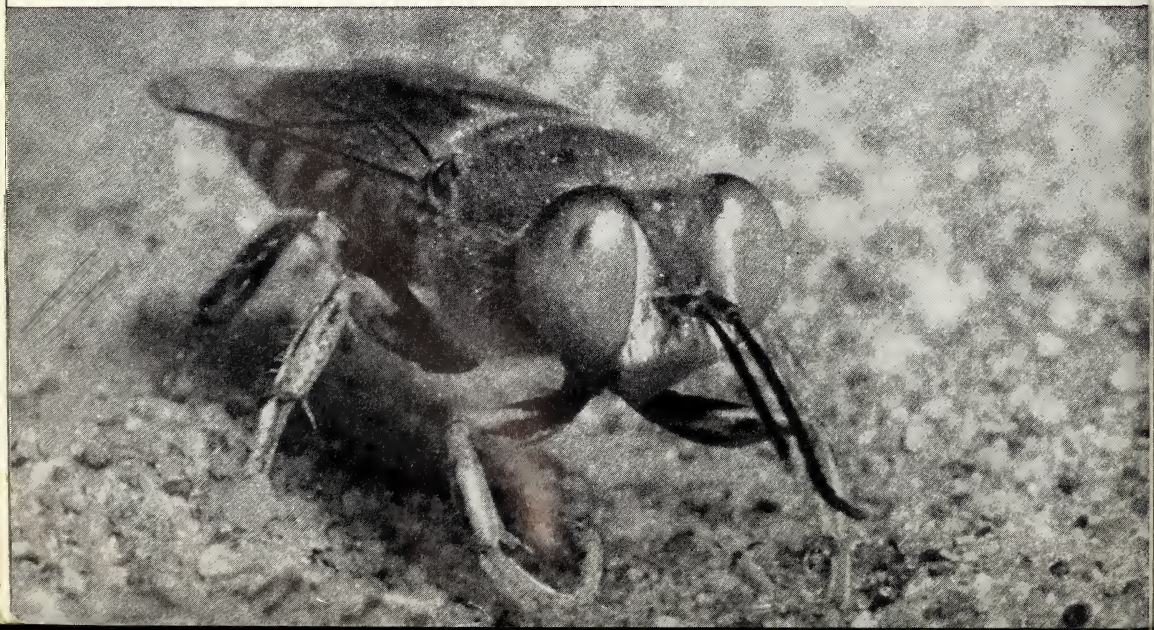
Bembix wasps dig like dogs

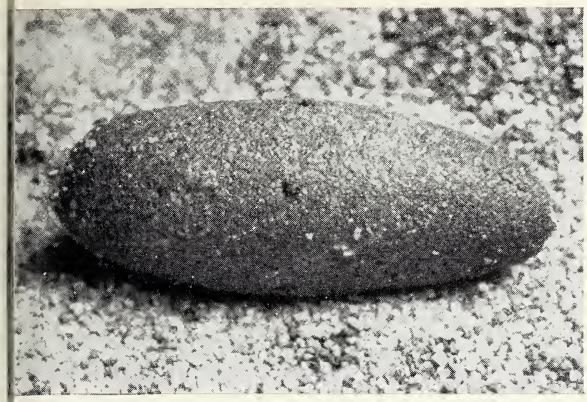
Busy Bembix

At work on a sand dune, a group of bembicid wasps appear like many little dogs throwing sand back between their legs as they dig. Although each is busy with her own private burrow, these wasps tend to work so close together that their holes may fairly riddle a section of the dune. Digging is done with doubled-up hairy front feet (see below).

After tunneling several inches, the wasp lays an egg, comes out, and scratches a temporary sand cover over the burrow's opening. She then scatters any telltale pile of sand that would indicate its location to her enemies.

Curved front feet do the digging





Mature bembix wasp larvae (right) make a hard cell of sand and saliva.

Then she goes off in search of a large fly to serve as food for her larva. Returning fly-laden, she alights with uncanny precision right on her unmarked closed tunnel, digs away the cover, and enters. Her growing larva needs a steady supply of fresh flies, which are brought in dead or nearly dead and hence are perishable. Quite often she also has to feed one or more maggots of a parasitic fly that laid eggs in the burrow in spite of all her precautions.

When the wasp larva is full grown, it constructs a hard, blimp-shaped cell. The walls of this cell consist of fine sand bound together with hardened saliva. The mature larva (above) overwinters in this chamber, pupates in the spring, and emerges as an adult with the coming of warm weather.

Larvae of certain flies are internal parasites of the adult wasps. The larval wasps, as well as their food, are often consumed by the maggots of beeflies, family Bombyliidae (below). It is interesting to see a mother beefly hovering just above a bembicid burrow and repeatedly dipping the tip of her abdomen to the sand as she lays eggs. The wasps spend a good deal of their time chasing these flies away from their diggings.

Subjects: *Epibembex occidentalis beutenmulleri* (Fox). Order Hymenoptera, family Bembicidae. Parasitic fly, *Exoprosopa* sp.

Photo data (both pages): Exakta VX with Heiland Strobonar flash.

This beefly is the chief enemy of bembix wasp larvae.

This wasp has just caught a grasshopper

44

Grasshopper Control

This grasshopper is suffering a fate common to its kind the world over. The wasp, which specializes in such prey, has given it a paralyzing sting and is dragging it toward a hole in the ground. Upon arrival, the wasp will release its grip, turn about, and pull the grasshopper into her burrow. An egg will be laid on the body of the victim. Then the hole will be closed as the wasp rams in earth with the top of her head. Soon the wasp grub will hatch and begin gnawing away at the body of the immobilized grasshopper.

This is but one of the many hazards in the life of a grasshopper. All help to keep grasshoppers from overrunning the world and eating up every green thing. Locally in certain regions, however, these enemies and other natural control factors are frequently overwhelmed by the number of developing hoppers. Then we have great destruction and mass migrations.

While driving across Argentina, where this picture was taken, we passed through a number of great, marching hordes of nearly mature grasshoppers. The shoulders of the road were pitted with the burrows of hundreds of these grasshopper-hunting wasps. They were seeing to it that many a hopper would proceed no farther. Perhaps there won't be quite as many grasshoppers around next year.

Subjects: *Chlorion* sp. Order Hymenoptera, family Sphecidae; prey, *Schistocerca* sp., juvenile.

Photo data: Exakta II, sunlight, no tripod.

Mud Dauber

This busy, thread-waisted, yellow and black wasp is one of the great variety of insects that frequent muddy places. Many are at home in such environments, others are only visitors in quest of something useful. Such visitors that are not merely after a drink of water generally pack up and carry off a ball of mud to be used as nest-building material.

The mud is gripped by the short front feet of the mud dauber, braced against the "chin" and jaws, and flown to the scene of building operations. For some unexplained reason the wasp makes a pleasant buzzing noise while gathering the mud.

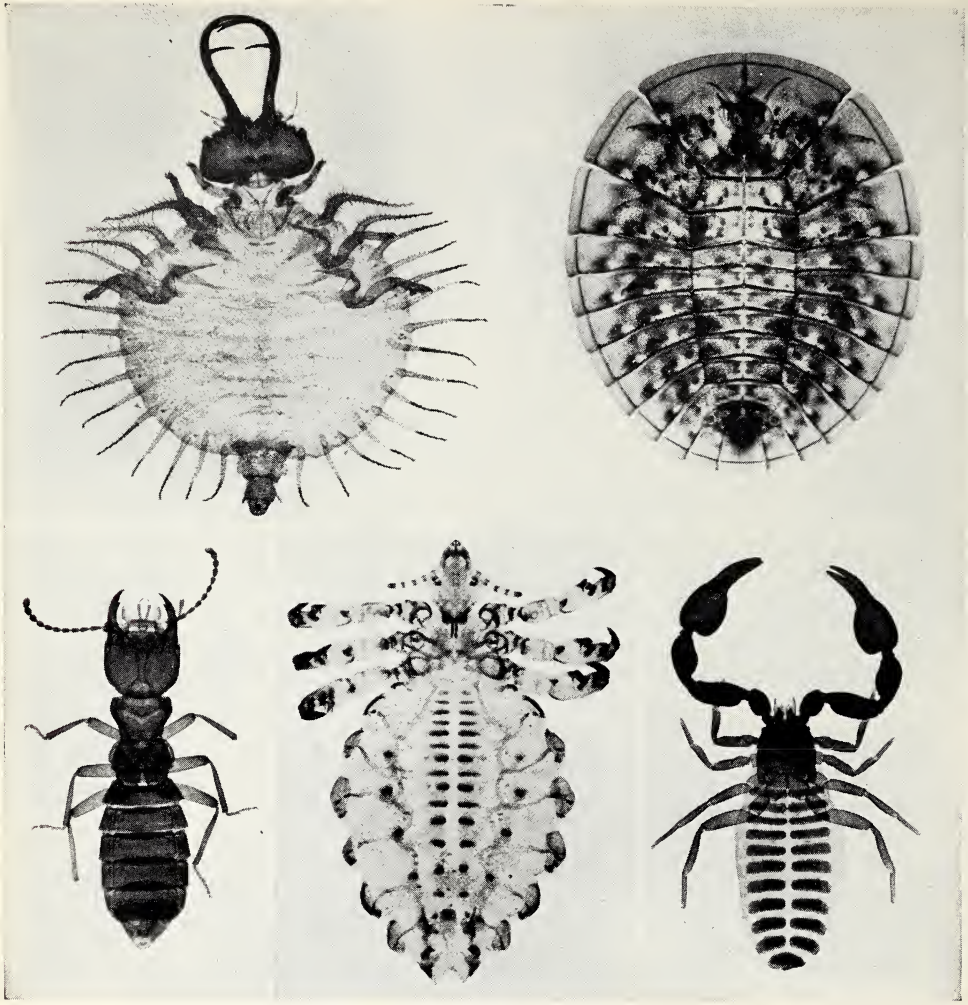
The mud is molded into elongated pots in a sheltered place, such as a rock crevice, cave, overhang, or a building. The mud is laid in slanted rings, and after a few pots or cells are finished their common exterior is fused and girdled with a mud jacket. Each cell is tightly filled with a variety of spiders that are dead or nearly dead as a result of the wasp's sting and other rough treatment. An egg is laid in the cell, which is sealed off with mud to become, in effect, a roomful of food for the developing wasp larva.

This would be a perfect situation except for the fact that a related shiny blue wasp (*Chalybion*) has the habit of tearing open these cells, throwing out the mud dauber's spiders, and replacing them with her own special collection of spiders and her own egg. Then she reseals the cells.

Subject: *Sceliphron caementarium* (Drury). Order Hymenoptera, family Sphecidae.

Photo data: Exakta VX with Heiland Strobonar flash.

Another ball of mud for the nest walls



Microscopic Beauty

Using the technique described on pages 71 and 72, it is possible to reveal the structural design of small joint-legged animals. These photographs are of microscope slide mounts made by these methods.

Upper left **is the larva *of Osmylops,* a curious Australian lacewing. It hides under eucalyptus leaves holding its jaws wide open to catch insects. *Upper right* is a "water penny," the larva of a small beetle *(Eubrianax).* These cling like suction cups to the underside of stones in streams. *Lower left* is a wingless rove beetle (Staphylinidae), one of the few insects that lives in the sea. At high tide it is submerged in rock or piling crevices in the barnacle zone of our Pacific shores. At low tide this carnivore wanders about the rocks searching for food. *Lower center* is a sucking louse (order Anoplura) from the fur of a Chinese water buffalo. Note its grappling feet and the breathing or tracheal tubes within the abdomen. *Lower right* is a false scorpion, a small creature that lives under stones, bark, and similar objects. It never has a stinging tail like the true scorpion.**

Photo data: Hasselblad with Novoflex bellows extension, Microtessar lens and Strobonar flash. Direct photography without microscope. Not enlarged to scale.

Blue butterflies sit together while drinking

Sociable Drinkers

One of the joys of a spring or summer stroll is the sight of a myriad of tiny blue butterflies sipping water from a muddy spot along the road or trail. For some unexplained reason these blues like to bunch together. When disturbed, they fly up like blue confetti. Here we see a friendly trio with antennae criss-crossed and with straw-like beaks sucking up drink just like children enjoying a soda from a common glass.

Volumes could be written about the strange habits of members of this family, the Lycaenidae. The caterpillars resemble grubs more than the familiar type of worms we associate with butterflies. Most have special glands which exude a sweet fluid that is highly prized by ants as food. To protect the supply, ants take care of the worms—even to the extent of building "sheds" to protect them from parasites. The butterflies benefit from this care, and their habits are closely interrelated to those of the ants.

Caterpillars of certain blue butterflies may spend only the early part of their life as vegetarians above ground. As they mature they lose their interest in foliage and wander about. They then seem to encourage the ants to carry them off to their nest. In the dark ant galleries the caterpillars overwinter and feed on the larvae of the ants. This nursery robbing is forgiven because the ants clamor for the delectable winter supply of sweets provided by the butterfly larvae. In the spring the worms pupate and soon transform to adults. The sight of a delicate butterfly coming out of so hazardous and unlikely a place as an ant nest must indeed be a cause for wonder. The actual expansion of the wings is delayed until the butterfly is out of the narrow nest galleries.

Subject: *Lycaenopsis pseudargiolus echo* Bdv. Order Lepidoptera, family Lycaenidae.

Photo data: Exakta II, sunlight, no tripod.

Butterflies and moths suck food through a tube

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Butterfly Portrait

With her shiny black "beak" dipped in one of the corollas of this daisy, this painted lady butterfly exhibits a feeding organ that is typical of all butterflies and most moths. In a moment she will plunge it to the hilt to pump nectar from the very bottom of the flower.

This tube, which is coiled like a watch spring when not in use, is composed of two long, fused parts. These are the galeae, which are quite small in most insects, being subordinate parts of the second pair of mouth appendages, the maxillae. The first pair of mouth parts, the mandibles, so prominent in beetles and other biting insects, are reduced to practically nothing. The fused third pair of appendages, the labium, contributes its palpi (fuzzy structures at base of beak) as the only other prominent mouth structures of butterflies.

Also evident in this picture is the fact that this butterfly uses only its two hind pairs of legs for walking. The front legs are small, densely covered with hair, and held close to the "chest." The name, "brush-footed butterflies," is given to the large group having this type of foreleg.

Experiments have shown that butterflies taste with their hind feet. As soon as these tarsi contact something edible, the beak uncoils. The antennae, or feelers, appear to be organs of smell.

Subject: *Vanessa cardui* (L.). Order Lepidoptera, family Nymphalidae.
Photo data: Exakta VX with Heiland Strobonar flash.

A jaunty skipper prepares to feed

Skippers

Muscular, thick, moth-like body; short, rapidly vibrating wings; hooked antennae—all these things are characteristic of skippers. These abundant, nervous little creatures are not true butterflies, however, nor are they closely akin to the moths. They make up a special group, the superfamily Hesperoidea. Because they fly by day, they are usually included in the catch of a butterfly collector.

The early stages are as distinctive as the adults. The caterpillars are dull-colored, seldom ornamented with spines or tubercles, as are those of true butterflies, and the head is distinctly set off from the rest of the body by a neck-like constriction. Grasses and sedges are the principal food plants of caterpillars of the type of skippers (subfamily Hesperiidae) pictured here. These live in silken nests and generally feed at night. Pupation, unlike that of butterflies, occurs in a loose silken coccon.

The study of skippers, especially their biology, offers much opportunity for new discoveries.

Subject: (Upper) *Atalopedes campestris* Bdv., (lower) *Ochlodes agricola* Bdv. Order Lepidoptera, family Hesperiidae.

Photo data: Hasselblad (upper) and Exakta VX (lower), both with Strobonar flash.

Face to face with a skipper

One-horned Giant

Anyone who has ever been in a field of tomatoes or tobacco has seen these giant, leafy-green, horned monsters greedily chewing up the foliage. They are called hornworms because of the peculiar projection of the tail end.

Our specimen clearly exhibits its breathing openings, called spiracles, which, appearing like portholes, occur in pairs on all but two front body segments. Each spiracle, as in all air-breathing insects, is the intake and/or exit point for air entering a vast many-branched system of tubes or tracheae of ever-decreasing size. These carry oxygen to all parts of the body.

Those conspicuous, diagonal white stripes suggest leaf veins. In combination with the worm's green color, they must help it avoid its enemies by causing it to resemble the missing half of the leaf recently transferred to its stomach. This disguise must function best when the worm is on the midrib of broad leaves, such as those of tobacco.

Hornworm on tomato vine

Going underground

Hornworm pupae look like little brown jugs

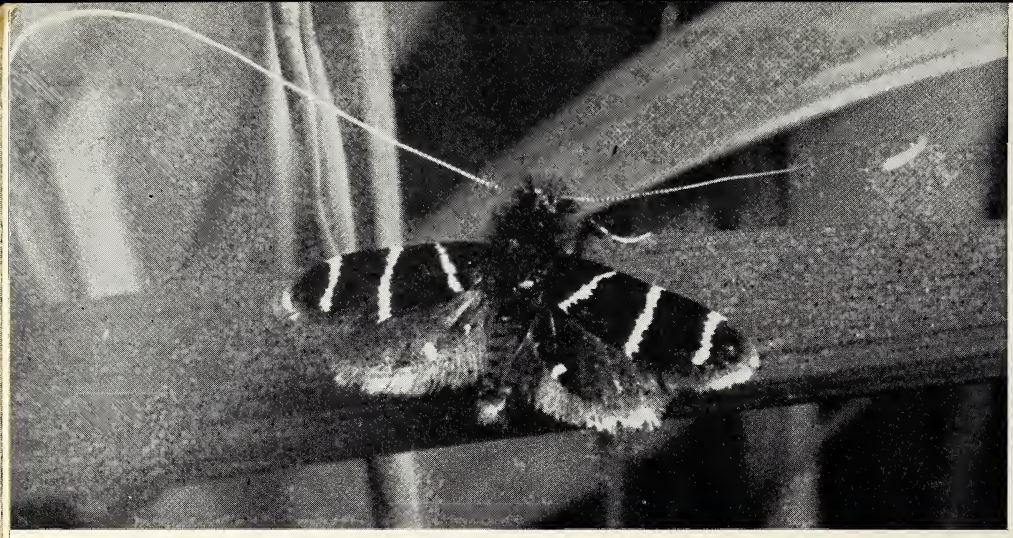
When full grown these four- to five-inch worms burrow into the ground and form an earthen cell in which the skin is shed. This act reveals a wonderful, hard, mahogany-brown chrysalis. "Little brown jug" is a good name for these because of the neat handle formed by the sheath protecting the beak of the developing adult. As in all chrysalids, the promise of things to come is evident in many ways. Note the cases for the development of the wings, antennae, eyes, and legs of the adult forming within. When the adult is fully developed and ready to emerge, the chrysalis, with strong twists of the pointed abdomen, burrows up to the surface of the ground.

The adult of the tomato hornworm (below) has a beautiful pattern of grays and black with yellow spots down the sides of the abdomen. The family to which these moths belong is large and varied. Most species have this airplane-like form, and rival the hummingbird in flight. With a tongue longer than the body when uncoiled, the moths hover in front of flowers to suck nectar. They tend to fly at dusk and dawn, when the nectar flows best.

Certain tropical orchids appear to depend on these hummingbird moths for cross-pollination. Nectar in the deep orchid corollas is accessible only to such long-tongued moths. As the nectar is sucked, the moth's eyes become coated with pollen, which is then carried to the next orchid the moth visits. In Madagascar there is one of these moths with a tongue long enough to reach the bottom of an orchid flower eleven inches deep!

Subject: *Protoparce sexta* (Johan.). Order Lepidoptera, family Sphingidae.
Photo data (both pages): Exakta VX with Heiland Strobonar flash.

Adult hornworm moths have an airplane-like form



Delicate white antennae grace this tiny moth

Micro-moths

Here on a grass blade is a beautiful example of a micro-moth. This black and white species is noted for its long, delicate antennae.

Some of the most beautiful objects in nature are to be found in the often ignored assemblage of tiny moths. Their small size makes necessary the use of special collecting and mounting methods. Students prefer to raise each species if possible to secure perfect specimens and to gain a knowledge of early stages and habits.

Subject: *Adela trigrapha* Zeller. Order Lepidoptera, family Adelidae.
Photo data: Exakta VX with Heiland Strobonar flash.

Moths on the Window Pane

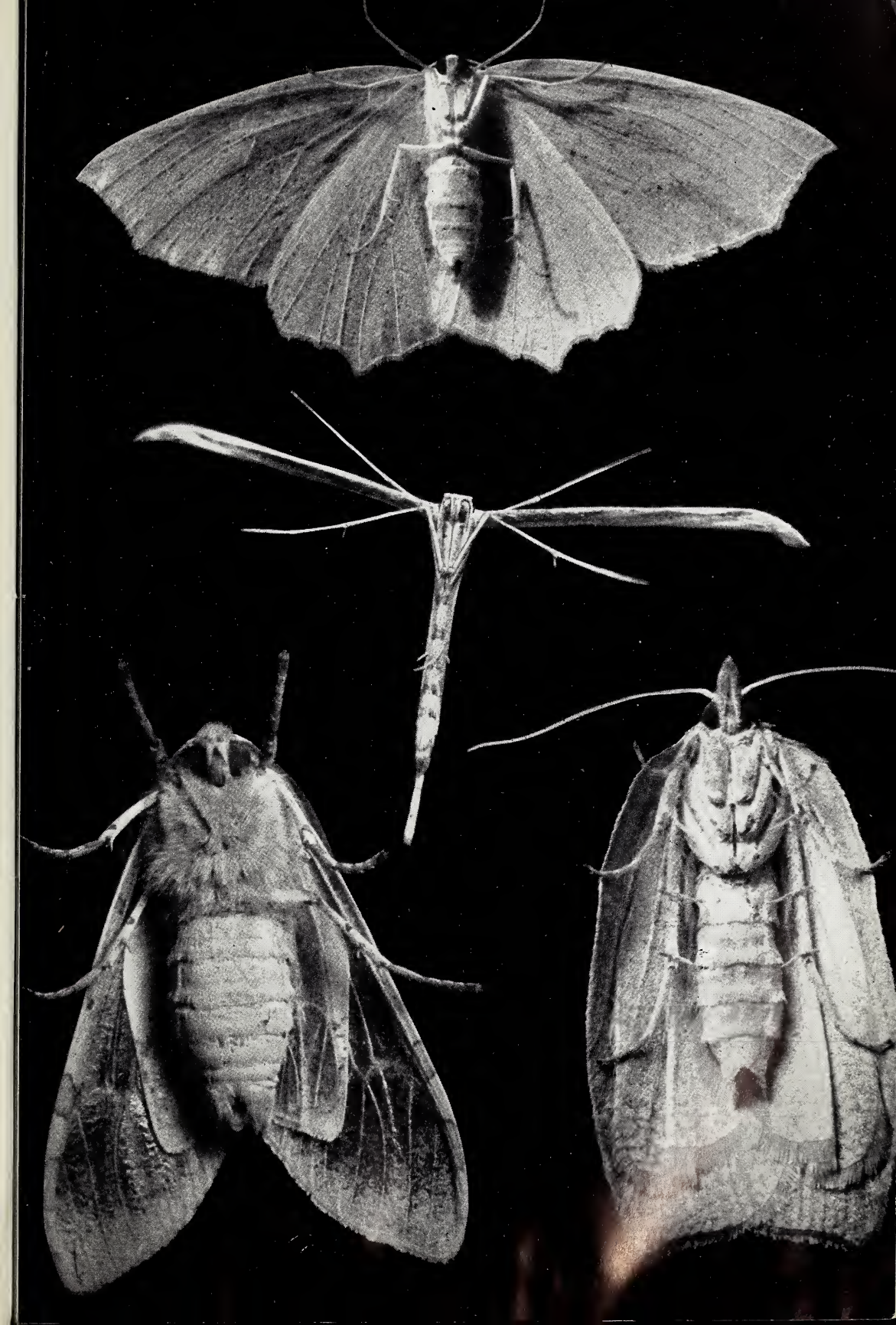
I never cease to marvel at the great variety of moths that fly out of the night and sit on the window sharing my light. The size, shape, and sitting posture of each is quite specific and more or less follows classification.

For example, the broad wings of the upper kind shows that it is a geometrid, the adult of a measuring worm or looper. The slender moth below it is a plume moth, a relative of the one whose worms eat holes in our globe artichokes. The common-looking moth (lower left) would pass for the adult of a cutworm, but it is actually a tiger moth that grew up from a woolly-bear caterpillar. The much magnified moth (lower right) shows by its curved wing outline that it is a tortricid. Larvae of this family burrow just under the skin of fruit; others curl leaves.

Collecting moths that come to light has started many a person off on an interesting lifetime hobby.

Subjects: Not enlarged to scale.
Photo data: Exakta VX (upper) and Hasselblad (lower two) with Strobonar flash.

A collection of moths on the window



Leaf Miner

In these pictures (opposite) a moth larva is at work in the snug interior of a live oak leaf. The egg was laid along the leaf's mid-vein near the stem. Newly hatched, the larva at first burrowed in a narrow meandering path. Then it abruptly expanded its activity to form a great, whitish blister. Removal of the top membrane clearly reveals the tiny larva and exposes its habit of eating the tender cells. Only a skeleton of firm veinlets remains.

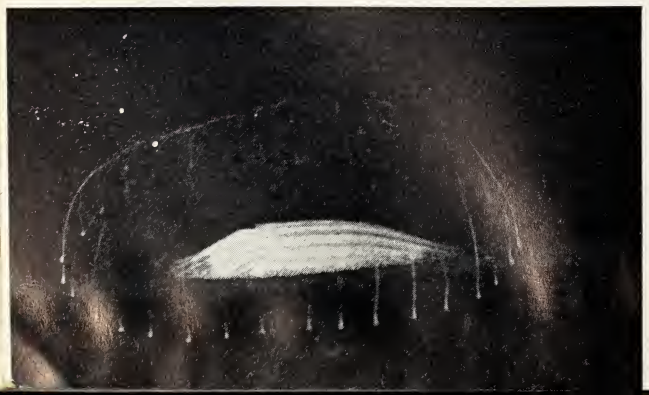
Judging from the large variety of small insect larvae that tunnel between the surfaces of leaves, or just beneath the skin of fruits and stems, we can be certain that this way of life offers many advantages. This so-called mining activity, which causes a characteristic whitish pattern, is chiefly the work of the caterpillars of tiny moths. Small fly maggots and the larvae of sawflies (wasps) and certain beetles also contribute their mining designs to the surface of plants.

Living under a tissue-like epidermis perhaps does not give complete protection from enemies, such as birds and parasites, but it must provide excellent control of temperature and moisture. Such tiny bits of life, as are these larvae, would certainly soon succumb to the sun's moisture-robbing rays without this shield.

Fence of Silk

This minute, ribbed, silk structure, made by the larva of a tiny moth, is perhaps the most remarkable cocoon in nature. Our example here, on a live oak leaf, is only three-sixteenths of an inch in length. Before starting the main cocoon, the larva spins a beautiful circular fence of silk, which must serve to discourage the attacks of wandering enemies. The little worm needs all the protection it can get, because its complex cocoon, unlike that of most moths, is largely constructed while the worm remains outside. This is done in two installments. First, a sock-like structure, open at one end, is rapidly spun. The worm then crawls into this and closes the open end (see union just left of center in this picture). All this spinning is accomplished in a mere half hour!

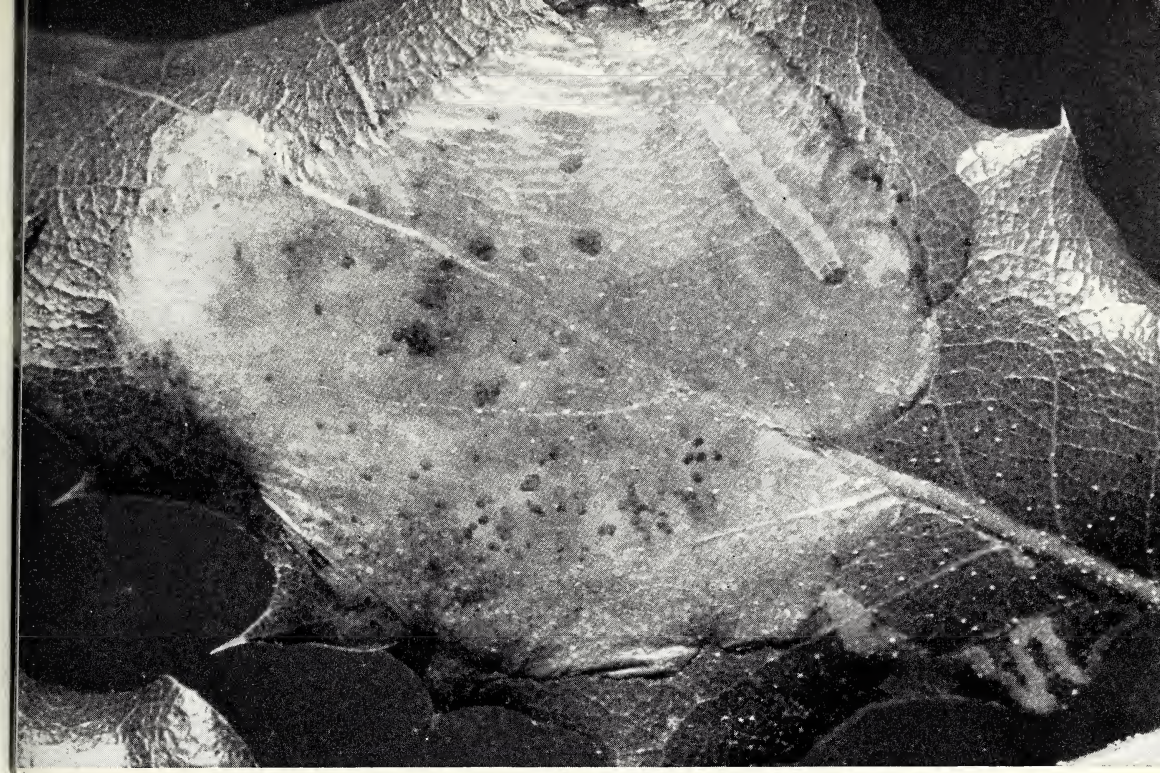
Having served its usefulness, the "white picket fence" soon weathers down. Even when perfect, it doesn't show up well unless the light strikes it at a certain angle.



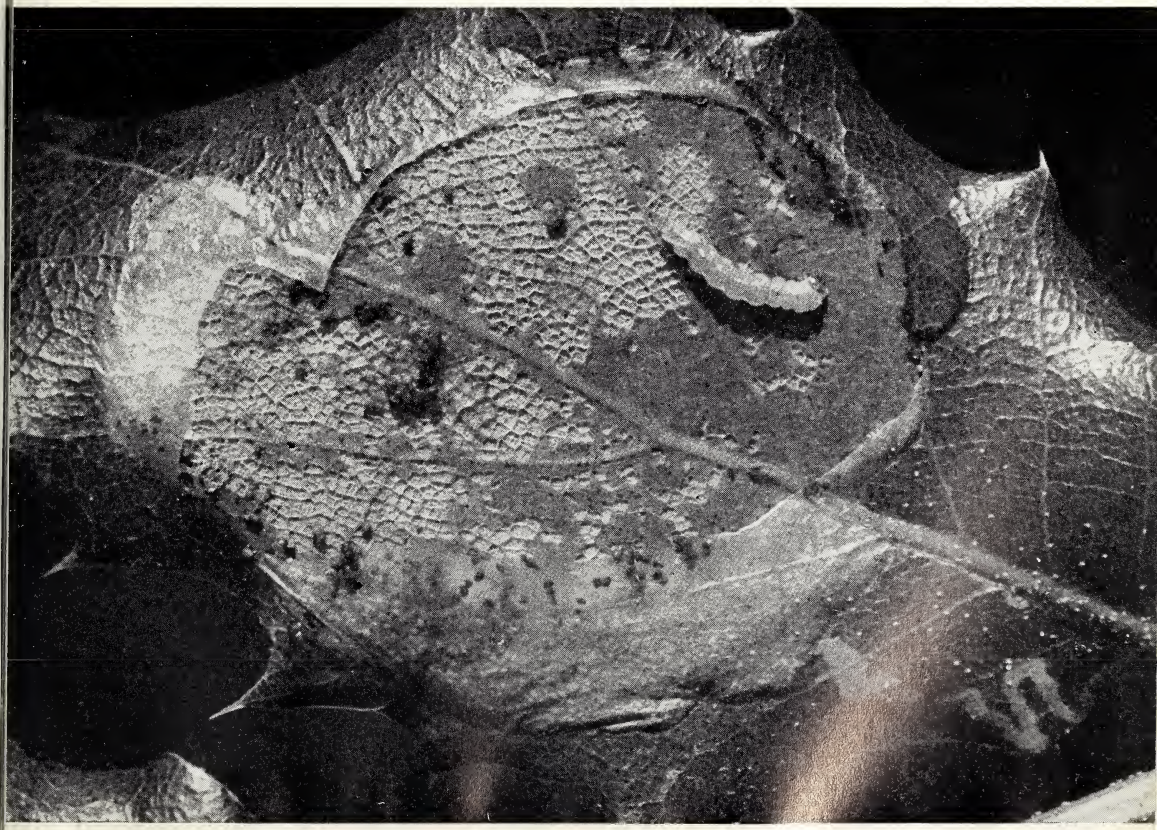
Subject: Cocoon of *Buccalatrix albertiella* Busck. Order Lepidoptera, family Lyonetidae.

Phota data: Exakta VX with Strobonar flash.

A moth cocoon surrounded by a barrier of silk



Tiny larvae find safety and food inside leaves



Subject: *Lithocolletis* sp. Order Lepidoptera, family Gracilaridae.
Photo data: Exakta II with flood lamp.

Mosquitoes out of Trees

A slight ripple on the surface of the coffee-colored water trapped in this rotted-out tree hole gives this girl a hint of the teeming life that struggles to exist in this highly competitive, crowded environment.

Mosquito larvae and pupa from tree-hole water

If she were to hold a jar of the murky water up to the light she would very likely see scores of very active mosquito wrigglers and pupae like these. The wigglers living in such small accumulations of water are noted for their long, balloon-like anal gills. These organs are said to be used to regulate osmotic pressure in waters of low mineral-salt concentration. They may also absorb oxygen from the water and enable the larvae to stay beneath the surface longer and better compete for the limited food. Mosquito larvae in larger environments, where there is more living space, generally have much smaller gills. In either case, however, the main breathing is done through a trolley-like tube that just breaks the water surface.

All over the world many kinds of mosquitoes develop in tree holes. Usually they are beautifully marked and often metallic in coloration. Most bite during the day in the shade, approaching with a high-pitched hum. They are difficult to control because of their scattered, out-of-the-way breeding places. The only permanent control is filling up the tree holes, but this is practical only when the trees are not numerous.

In warm regions, as our army in World War II experienced, certain species spread a very unpleasant but non-fatal disease called dengue. In Central and South American jungles certain tree-hole species are responsible for keeping yellow fever a constant threat in spite of its eradication from human communities. A steel-blue tree-hole mosquito *(Haemogogus)* is responsible for the spread of yellow-fever virus among monkeys high up in the trees. There is a constant danger that forest workers, such as wood cutters, will be bitten by mosquitoes that have bitten infected monkeys. The workers could then carry the virus to densely populated areas, where it would become available for rapid spread by the true yellow-fever mosquito *(Aedes aegypti* L.). This species prefers to breed in artificial receptacles around towns and villages.

Subject: *Aedes varipalpus* (Coq.). Order Diptera, family Culicidae.
Photo data (both pages): Exakta VX with Heiland Strobonar flash.

Adult tree-hole mosquitoes are beautifully banded

Mosquito emerging from its pupal shell

Another Mosquito Is Born

The emergence of a mosquito from its comma-shaped pupal shell is a most interesting event. The straightening out of the tail of the "comma" signals that the adult inside is at last fully developed and ready for a completely different life out of water. An air bubble that all mosquito pupae carry between their wing buds for stability and buoyancy now begins to spread out and separate the skin of the pupa from that of the adult. Some of this air is sucked into the mouth of the mosquito and passes back into its abdomen. The pressure pushes the adult forward and splits open the back of the pupal skin. Once its head is out, the mosquito pumps in more air (by the same action it later uses to suck in blood or other liquid food) and increases the abdominal pressure (note swellings in picture). This causes the mosquito to rise slowly and smoothly up and out of the shell as if propelled by some mysterious force. The long legs and wings are soon drawn out of their twisted sheaths, and the mosquito completely emerges and stands on the water surface. After a short period of drying and stiffening, it is able to fly off.

The white-banded beak and striped legs tell us that this female *Culex* belongs to the species that transmits an encephalitis virus from bird carriers to man and horses. The resultant disease is commonly called sleeping sickness.

Subject: *Culex tarsalis* Coq. Order Diptera, family Culicidae.

Photo data: Exakta VX with Novoflex bellows and Strobonar flash. Living specimen in micro-aquarium.

The spines on flies have special meaning to scientists

Portrait of a Beneficial Fly

"Flying hedgehogs" would be a fitting name for these abundant, spiny flies of the family Larvaevoridae. As a rule, any common-appearing fly with such prominent bristles is a member of this beneficial group. The larva are always parasitic on insects—especially the caterpillars of butterflies and moths.

This species does not lay eggs. Instead, the female deposits thousands (2,000 to 8,000) of tiny living maggots on the food plant of its host caterpillar. The maggots enter the caterpillar's body through its mouth as it feeds on the leaves.

The adult flies are not at all attracted to filth and hence are of no danger to our health. They are frequently seen partaking of the nectar of flowers. These flies include many kinds, some of which are colorful and beautiful.

Those projections on the "forehead" of the fly are antennae. The more "advanced" flies, such as this, have the first two antennal segments greatly enlarged to form the lobe-like structure. The other segments make up the bristle-like extension known as the arista. These antennae are certainly different from the slender "feelers" of such insects as the lacewing (p. 37).

The arrangement of bristles on the head and bodies of flies is not haphazard, but so definite and consistent that it is useful in classification.

Subject: *Paradejeania rutiloides nigrescens* Arnaud. Order Diptera, family Larvaevoridae (Tachinidae).

Photo data: Exakta VX with Strobonar flash. Living specimen on window sill.

Spiny legs and a sharp beak are tools of the robber fly's trade

Insect Hawks

Robber flies are the hawks of the insect world. Alertly perched on a stone or stick, these sharp-eyed flies can suddenly fly out and capture in hairy-legged clutch any suitable insect that flies into range. A sharp beak stabs the victim, a saliva that liquifies tissue is injected, and the fly returns to its perch leisurely to enjoy its meal. As I focused on the fly pictured, upper right, it suddenly left the stone, caught a green leafhopper flying by, and quickly and conveniently returned to the same perch, allowing me to take its picture.

More than 5,000 different kinds of robber flies inhabit the world and show a great range in size from that of quarter-inch pigmies (left) to giants more than two inches long. Some are noted for their resemblance to other insects such as wasps and bumblebees. The larvae live in a variety of places such as under bark and in humus. They may either be scavengers or predators.

Subjects: *Erax barbatus* Fab. (upper, both pages) *Coleomyia setiger* (Cole) (lower left). Order Diptera, family Asilidae.

Photo data (both pages): Exakta VX with Strobonar flash except lower left is Exakta II in sunlight.

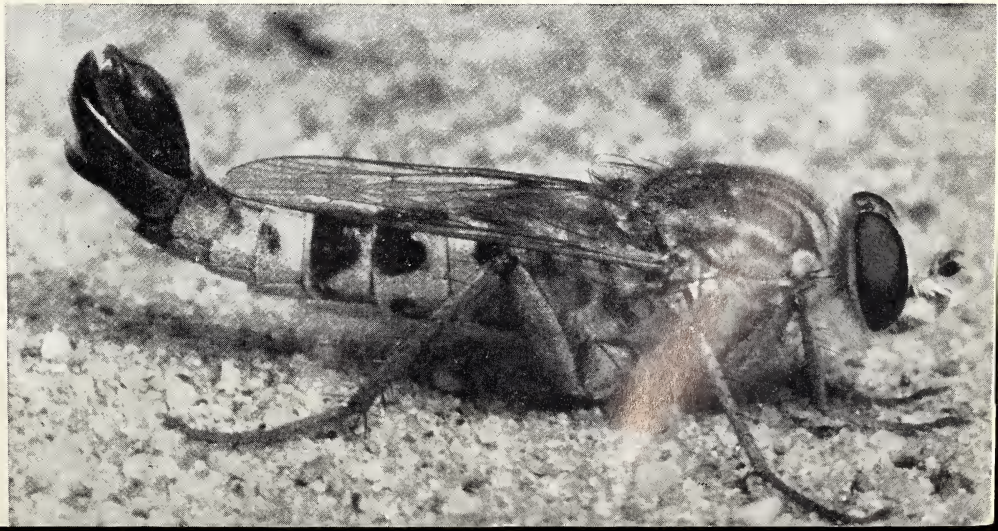
One of the smaller robber flies

This robber fly is enjoying the juices of a leafhopper

Pictured below is a member of the above robber fly's community. It belongs to the Apioceridae, a family of rare flies of which only about fifty species are known. Although not closely related, these two flies have deceptively similar form, coloration, and movement. To date, the biology of apiocerids is almost completely unknown. Thorough study might well explain why this kind resembles this particular species of robber fly. Its housefly-like lapping mouthparts and slender legs would seem to rule out the possibility of a predatory feeding habit.

Subject: *Apiocera haruspex* O.S. Order Diptera, family Apioceridae.

This apiocerid fly seems to mimic the above robber fly



Insects for Pleasure

Through these pictures and short sketches I have attempted to reveal some of the wonder of the insect world that is everywhere about us. I hope I shall at least awaken a more friendly and understanding attitude toward insects. Perhaps your garden will now be viewed as much more than an assemblage of plants but also as an attraction and a home for animal life, large and small. True, at times the sacrifice of foliage and blossom is too great an admission price to pay for a ringside view of the drama of insect life, and occasionally we must resort to artificial control. As a rule, however, the greater our knowledge of insects the more sparing and selective is our use of the spray gun. We come to realize the importance of permitting the natural enemies of our pests to live their lives and come to our aid.

Throughout the year the calendar of insect events is a full and varied one. Much happens that has never been scientifically observed or recorded. This is because there are all too few scientists to cover the vast field of entomology. In spite of a common impression, most insectkind —perhaps 99% of it—is of no direct economic importance and thus can seldom be justifiably studied as an official duty by professional entomologists who are usually paid from public funds. Who, then, will study the non-economic bulk of the insect world? The answer is that much of it must be studied by skilled amateurs who do the work for the love of knowledge and the deep satisfactions that come from investigating the unknown. I am hoping that you will want to become one of these skilled amateurs by taking up an entomological hobby and staying with it long enough to contribute to science.

The urge to explore, hunt, and engage in other outdoor activities in which the tantalizing suspense of the unpredictable is a dominant part, is deeply rooted in the basic makeup of normal persons. The satisfaction of this urge is important to our physical and mental well-being. In these modern times nature hobbies offer excellent constructive ways of accomplishing this.

Insects are fine subjects for such hobbies for they are everywhere and free for the taking or observing. Naturally, however, one should collect only what he needs and preserve the specimens well. The quest for specimens, observations, or picture subjects gives real purpose to our travel, whether it be a Sunday stroll, a two-week vacation trip, or an extensive journey abroad. Everywhere we go there awaits something exciting to discover or do. The "souvenirs" we bring home have permanent and often unique value if properly preserved, labeled, and, in due course, lodged in a museum. The insect hobby also provides pleasant indoor work for evenings and winter days as well as a basis for a strong

bond of friendship with persons doing similar work. For youth, entomology provides an inexpensive, constructive pursuit for the body and mind—one that can be a great asset toward developing a career in any branch of science.

Among the many hobbies available to the student of insects are:

1. The observation of insect habits or biology. These may deal with the life of just one species, or a group of species, or they can involve the interrelationship of the various kinds that make up a natural community such as a pond, a meadow, or a sand dune.

2. The collecting and classifying of insects. You can try to collect all the species that live in a given space or region—your garden, your county, state, etc.; or you may collect all species associated with a single host or habitat, such as one species of plant, a stream, animal burrows, caves.

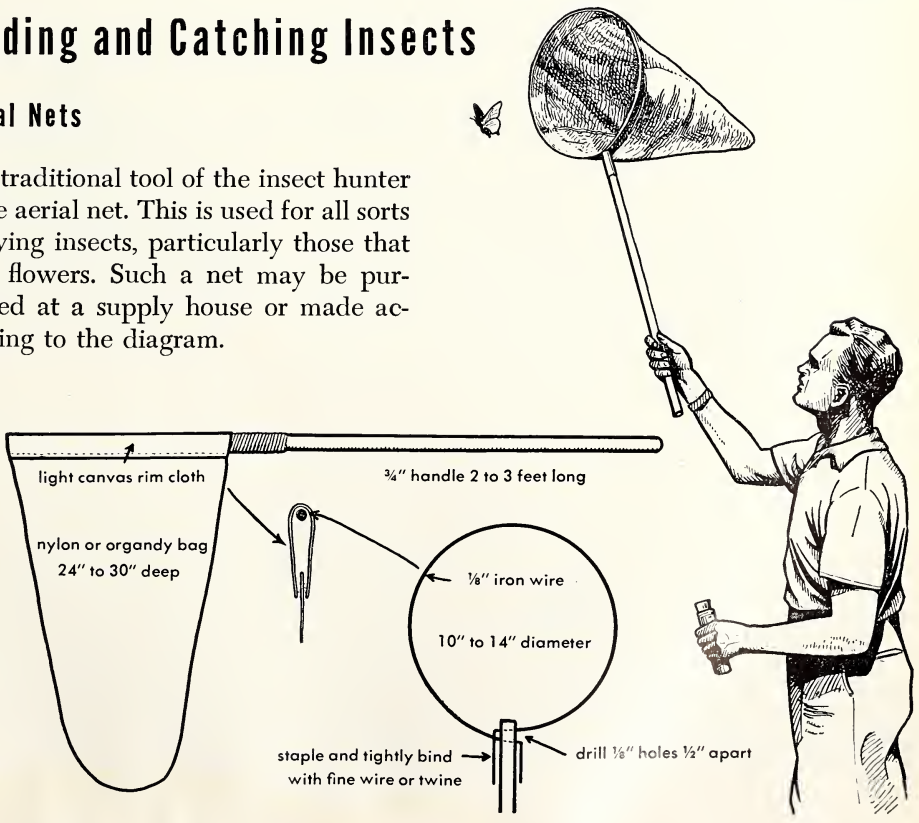
Most collectors, however, specialize in a group of insects. Thus they may become specialists in such groups as dragonflies, butterflies, or a family of beetles.

3. Insect photography. The opportunities in insect photography are limitless to those willing to secure the proper equipment and exert the necessary patience and effort.

Finding and Catching Insects

Aerial Nets

The traditional tool of the insect hunter is the aerial net. This is used for all sorts of flying insects, particularly those that visit flowers. Such a net may be purchased at a supply house or made according to the diagram.



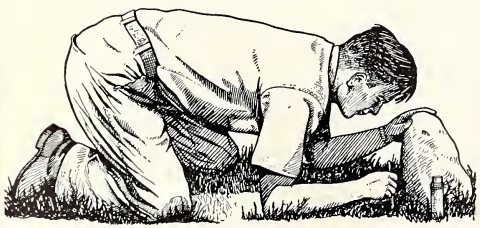
Sweep Nets

Strong frame nets with a nylon, organdy, or light canvas bag are swept forth and back across meadows, flower patches, and lower tree limbs. In this way hundreds of otherwise overlooked specimens may be caught. When time is limited, the contents of the net bag, leaves and all, may be dumped into a large jar or box. A few drops of ethyl acetate may be added for killing. This container can later be emptied on a smooth surface and the sweepings picked over for specimens.

Water Nets

The nylon aerial net can also be used for catching water insects. One way is to hold the net in the current of a stream while dislodged insects are swept into it as stones and debris directly upstream are turned.

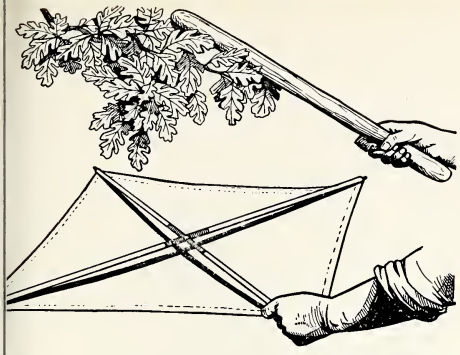
The net may also be gently swept through the water in ponds, lakes, etc. The debris that collects in the net may be dumped on shore and examined for specimens. A common kitchen sieve is another good tool for aquatic collecting.



Searching

One of the most important ways of collecting is searching. All one needs besides collecting jars and vials are sharp eyes, tweezers, and a tool for prying—a stout screw driver or a geology hammer.

Look under stones, logs, shore drift, bark, leaves, dung, and decaying matter, and in animal burrows and caves.



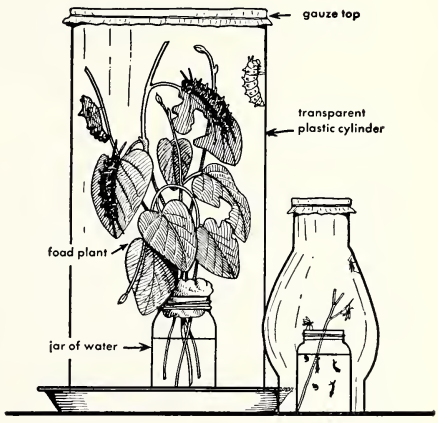
Beating

Insects may also be collected by beating them from trees and shrubs. A frame-supported square of canvas is held below the limbs to catch the specimens. Beating is best in the cool of early morning or by lantern light at night when the insects are too sluggish to get away.

Rearing

The most instructive way of collecting and studying insects is to rear them. There are many ways to do this. The easiest insects to rear are caterpillars. These may be taken home with a fresh "bouquet" of the kind of foliage they were eating. This is placed in a jar of water in a suitable cage. Frequently replenish the original kind of leaves, for generally insects are very particular about what they eat.

When full grown they will transform as chrysalids or spin cocoons. Some kinds require a bed of soil in the cage in which to burrow and pass the chrysalis stage underground.



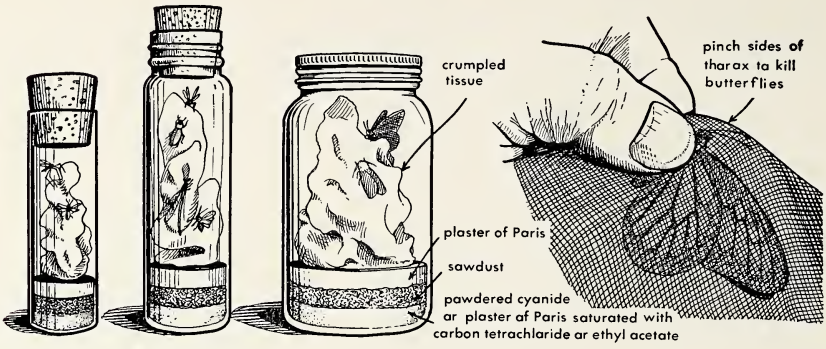
Other Collecting Methods

Many insects can be collected at lights, especially in the open country, away from a town or city. Warm summer evenings are especially productive. On trips to wilderness areas always bring a gasoline lantern to place on a white sheet laid on the ground. Following the first summer rains in arid or desert regions, insects will fly to your light in tremendous numbers and great variety.

Small creatures inhabiting leaf mold and other debris may be collected by sifting this material onto a square of cloth through a quarter-inch screen. This concentrate may then be placed in a large funnel. As the material drys, the insects will work their way downward towards the funnel's apex. A vial of alcohol is attached to this lower opening to trap the insects as they fall through.

Some collectors use baited jars, buried with the mouth at ground level, as traps for insects. The bait may be rotting meat for carrion insects. A fermenting beer and molasses mixture will attract many other kinds. This bait may also be painted on the bark of trees and later examined for insects. Moths are frequently attracted to such "sugared" trees, so be sure to inspect them at night.

How to Handle Insect Specimens



Killing

Most experienced collectors prefer the lethal fumes of cyanide for killing insects, but this chemical is very dangerous. A good substitute is ethyl acetate or common carbon tetrachloride. Blotting paper, a tight wad of cotton, or a layer of plaster of Paris may be placed in the bottom of the container to carry the chemical. As the jar is frequently opened and closed, this chemical will dissipate and should be replenished from a stock bottle carried in the collecting bag.

Many insects, except brightly colored, scaly, or hairy ones, can be killed in fluid preservative (70–80% alcohol). Soft-bodied forms are permanently stored in alcohol.

Most collectors, even experts, kill butterflies by pinching the sides of the thorax through the net bag. This is the point where the wings and legs join the body. Be sure the wings are up over the back before pinching.

Temporary Storage of Insects

During a day of collecting, the killing jars should be emptied as soon as possible after the death of the specimens (about one-half hour to be sure). These should be placed in small boxes with a bit of crumpled cleansing tissue or cellucotton (available in all drugstores) until you are ready to mount the specimens. This will protect them from damage.

If you are out collecting for several days or longer, as during a vacation expedition, the specimens may be stored on successive layers of cellucotton cut just to fit inside a cigar box. Put small insects on one layer, large ones on a separate layer. Place a locality and date label in each layer for future reference. Don't mix locality lots on any one layer. When the box is full (not too tightly) add some moth flakes, tape it shut, and start a new one.

Butterflies (after pinching) should be directly transferred from the net into glassine envelopes or folded paper triangles.

Relaxing Dry Insects

About twelve hours after their death insects will be dry and very brittle, so don't handle or try to mount them before they are relaxed. Relaxing may be done in the humid air of a tight-lidded, wide-mouth jar or can containing an inch or two of damp sawdust. A generous sprinkling of moth flakes or a few drops of carbolic acid *must* be added to prevent mold. Relaxing takes 12 to 48 hours. Don't permit the insects directly to contact the wet sawdust.

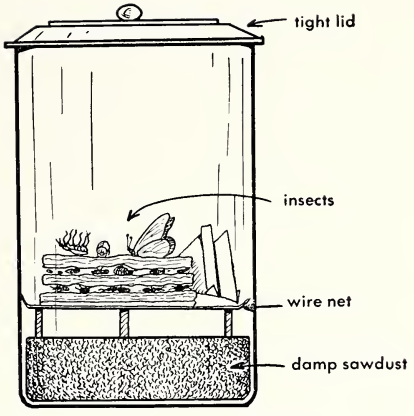
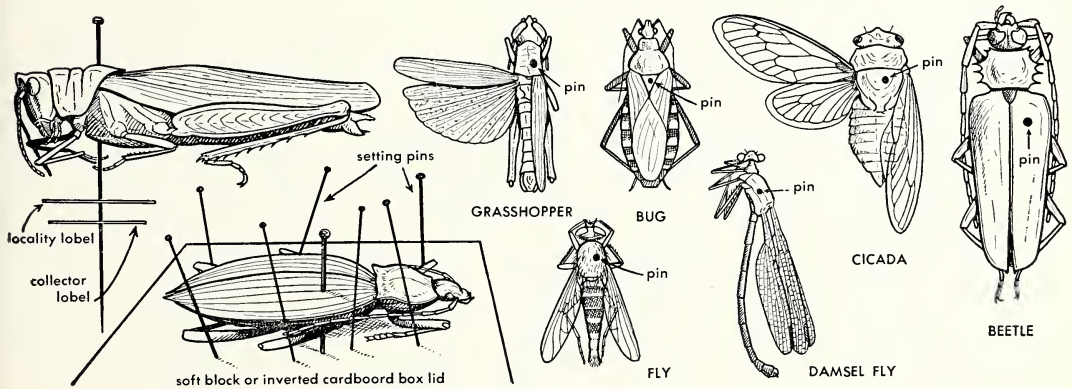


DIAGRAM OF RELAXING JAR



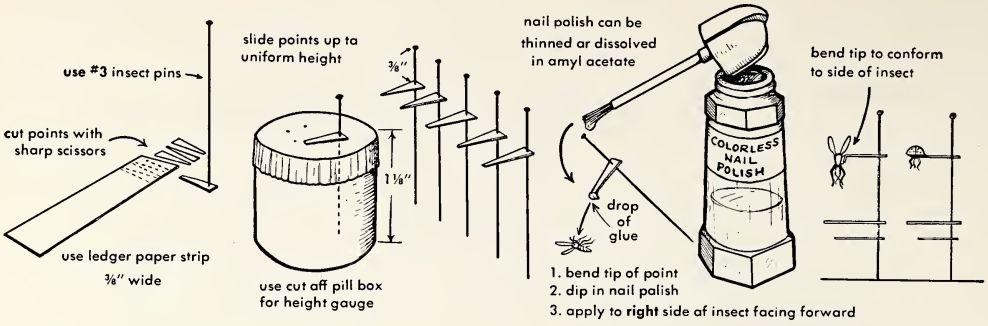
Mounting Large Hard-bodied Insects

Hard-bodied insects that are freshly caught, or just relaxed, are pliable and ready for mounting. No special preservative is needed because the soft inside parts dry up and the hard outer shell, or exoskeleton, preserves its original appearance.

With special black insect pins (sizes 2 or 3, purchased at one of the listed dealers) the larger insects are carefully pinned through special parts of the body. The standard places are shown in the drawings. It is important to avoid pinning through an unduplicated surface, so stay a little to the right of the central body line.

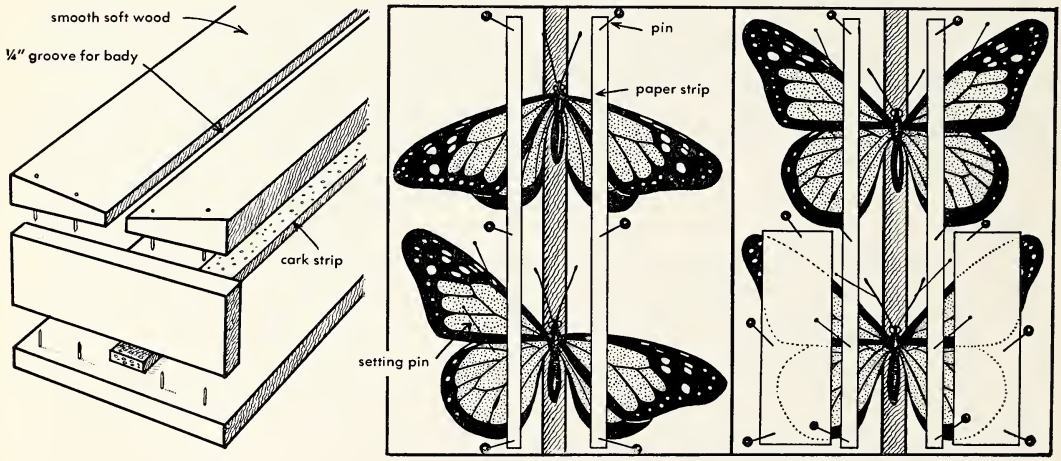
The drawings also show the positions in which the legs and wings of certain insects are set. Except for special display specimens, set the legs, antennae, and wings as close to the body as possible to save space and reduce breakage danger. This setting is done with side pins that hold the parts in place until they become dry and stiff.

Pin the insect so that it doesn't tip sideways, forward, or backward.



Mounting Small Hard-bodied Insects

Never pass a pin through insects that are less than one-quarter of an inch long. Instead, carefully glue each to the tip of a stiff paper point as shown in this drawing. For uniformity, keep the points the same height on all pins and always directed leftward.

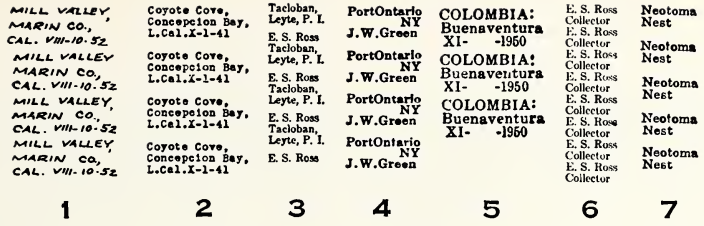


Mounting Broad-winged Insects

Special setting boards, as shown in the drawing, are used for neatly spreading the wings of butterflies, moths, and dragonflies. The wings are moved to position with the points of pins held just behind strong wing veins. In some insects, such as winged grasshoppers and cicadas, only one set of wings is spread (left side) so as to conserve space.

Labeling Pinned Specimens

Each specimen should carry neat little labels indicating where, when, and by whom it was collected. Without this information it would have very little value. Keep up with this task. Don't depend on your memory and don't use a system of notebook data correlated with specimen numbers to take the place of these basic labels. Notebooks may be used, however, for detailed information.



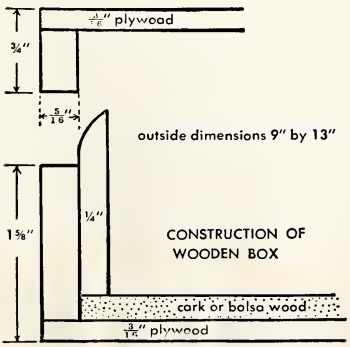
Here, figured actual size, are samples of labels used by collectors. Labels may be hand-lettered in India ink as in column 1. Column 2 shows labels from an impression of a portion of a zinc engraving of a typewritten sheet. Columns 3 through 7 show labels printed on a card press from hand-set type. Advanced collectors usually own a press and fonts of 3½- to 4½-point type. Ledger paper should be used for all labels for they must be permanent.

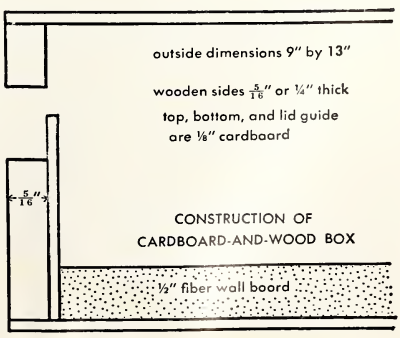
For the sake of uniformity, keep the top label the same height throughout the collection. The labels of point-mounted insects follow the direction of the point; others, except those of butterflies and moths, follow the longitudinal axis of the body and are readable from the left side. Trim all labels as close as possible to the printing.

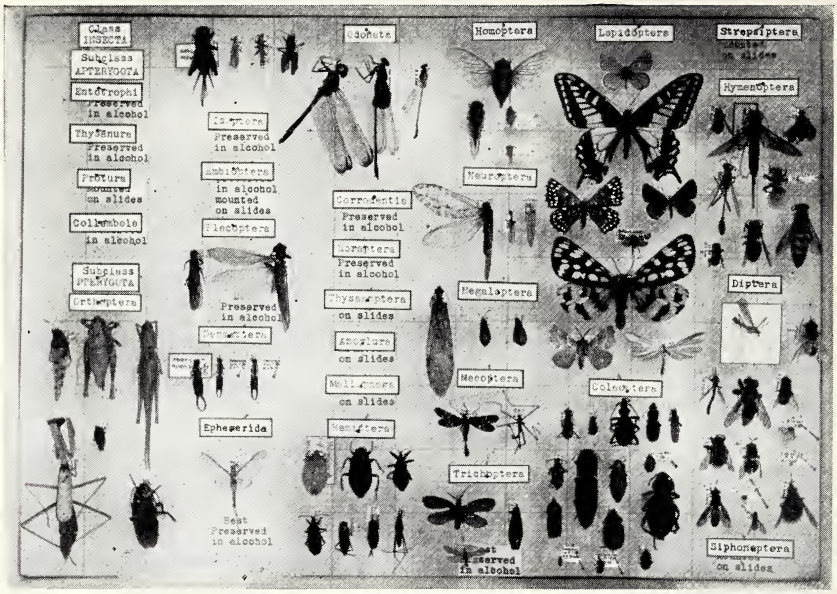
Storage of Pinned Specimens

Museums use rather elaborate and expensive cases and drawers for storing their large collections. The private collector, unless well advanced, should house his collection in standard insect boxes. These are about 9×13 inches and about 2½ inches deep. The bottom is lined with a soft material such as cork or balsa wood to receive the pins. Boxes can be purchased at one of the supply houses listed at the end of this book.

The economy-minded collector with a home workshop may prefer to purchase one good sample (Schmidt type) and pattern his own production to conform. Other collectors may be forced to adapt cardboard boxes or cigar boxes to their needs. Certain kinds of fiber wall board, or even corrugated cardboard, will serve for the pinning bottom. These improvised boxes must be frequently inspected because their contents will be more than usually exposed to the attacks of book lice and small beetles that eat insect specimens. A constant supply of moth flakes or crystals in each box in the collection is a good repellent.







70 Organization of the Pinned Collection

The beginner should make a neat set of labels for all insect orders and arrange them in "family tree" sequence as shown above. These orders are given in the standard texts listed at the end of this book. Make a label for each order whether you have specimens of it or not. In this way you learn the names of groups you haven't collected yet as well as those you have. These voids are challenges that add zest to collecting. The system works as it does in a stamp album which has the names of all countries printed in it.

As the collection grows, one or more boxes will be needed for each order. At this time the group-labeling system should be made to cover families and other groups lower than the order level.

Preserving Soft-bodied Insects

Many insects have such thin skin that they shrivel up when mounted on pins in the ordinary manner. These include such creatures as mayflies, stoneflies, termites, larvae, spiders, and centipedes.

These are best collected in corked or screw-topped vials or jars of 80% alcohol. Later they are sorted out in a petri dish and the series of each kind is placed in a separate vial of 70% alcohol closed with a tight cotton plug. A typewritten label giving the locality, habitat, date, and collector data should first be added. Printed labels can be used also. The vials are then inverted and immersed in a jar of 70% alcohol. The advanced collector will want to adopt shell vials of uniform length but of several diameters for this purpose.

From the very start avoid using separately corked or stoppered vials. Specimens so stored eventually dry up from neglect and are ruined.

Preserving Microscopic Insects

These may be temporarily preserved in alcohol or at times mounted dry on points. Later they can be mounted on microscope slides in balsam. As can be seen from the examples on page 46, slide making can be a fascinating hobby as well as a great aid in seeing in sharp detail the intricate structure of insects or related forms. Creatures best suited for slide mounts are those that are naturally flattened (e.g., fleas, lice, mites). Parts of larger insects can also be mounted.

The technique of making slides is basically simple and quite inexpensive. One drawback, however, is that a binocular dissecting microscope is almost a necessity. A compound microscope is also desirable for the close examination of the finished slides. Fortunately much good work can be done with less expensive second-hand instruments available at most optical dealers. Students and teachers can make use of equipment available in school laboratories. The chemicals and other apparatus can be purchased at one of the supply houses listed at the end of this book.

In this book only the basic rudiments of one of the several slide-making methods can be given. In this method you (1) empty the insect's skin of all soft parts (by use of KOH), (2) eliminate all water (by use of glacial acetic acid), (3) treat the skin so that it will transmit, not reflect light (by use of oil of cloves), (4) mount it in a permanent medium (Canada balsam) for preservation and observation.

Subject to refinements that develop with experience, here is a step-by-step outline of one slide-making technique.

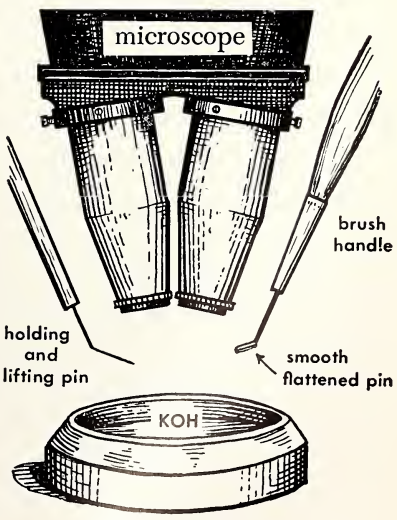
1. Place two pellets of potassium hydroxide (KOH) in a 1-inch crucible or equivalent container of clean water. Drop in insects. They may be recently killed, or those preserved in alcohol, or old, dried specimens (first wet these in 70% alcohol).

2. Gently heat crucible on hot plate or radiator, or allow it to stand cold overnight, until muscles and other body contents are softened or liquified.

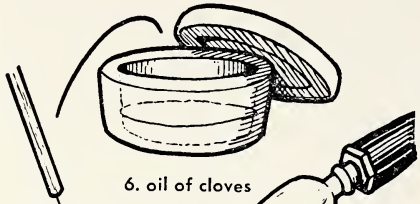
3. Pour KOH and specimens into small smooth-bottomed dish (Syracuse watch glass).

4. View under low-powered dissecting microscope and press out *all* body contents with flattened pin mounted in handle. The contents should escape through a small slit or puncture. Don't overlook contents of legs and antennae.

5. Lift empty skins on bent pin into tight-lidded dish of fresh glacial acetic acid. Allow them to remain in this at least one hour.

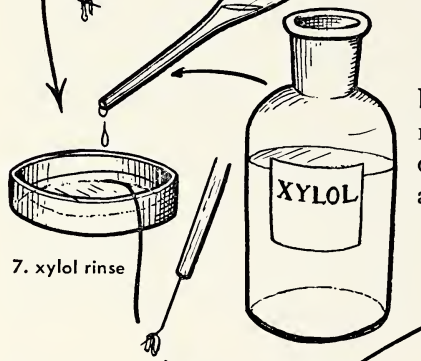


Syracuse watch glass

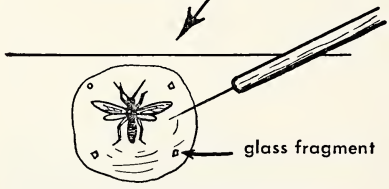


6. Transfer skins to oil of cloves. It may take at least an hour for them to clear (they then appear black against a black background).

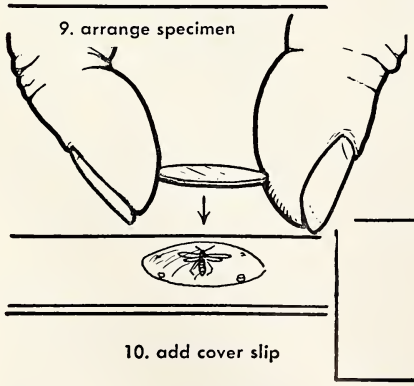
7. Briefly place skins in xylol to rinse out clove oil.



8. Transfer to drop of Canada balsam centered on standard 1″×3″ microscope slide. The tacky surface of the balsam may be softened by adding a drop of xylol.

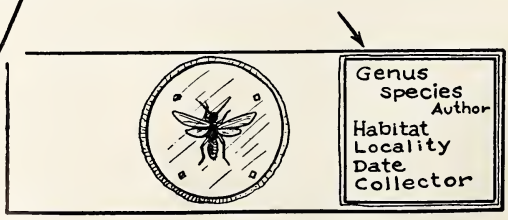


9. Under microscope arrange legs and wings. Place four pieces of crushed glass as thick as (but no thicker than—) specimen around it to support cover slip.



10. Drop circular glass cover slip in place (use 12, 18, or 22 mm. size according to need).

11. Label as shown.



Naming Your Specimens

This is a big problem, not only for the beginner but even for the expert. The trouble stems from the very reason that makes insect collecting important—that is, the insect world is very large and complex. It would take a great set of volumes merely to record the insects of even a limited region as completely as is done, for example, in bird guide books. Some of the books listed will be of help in naming the more conspicuous insects. For the most part you should at first be satisfied to merely group your specimens to the proper order or family. Later you can specialize and bring together the books and papers necessary for identifying species.

Ideally, the beginner should secure the assistance of some advanced collector in his region for help over the rough spots in naming the collection.

Becoming a Specialist

Many define a specialist as one who knows more and more about less and less. This may be true, but on the other hand it is possible to define a non-specialist as a person who knows less and less about more and more. Avoid specializing before you have a general knowledge of insects, but as soon as possible concentrate your efforts on some special phase of the subject.

The field of entomology is, potentially at least, the biggest branch of natural science for three-fourths of the kinds of living things are insects. Each has its own particular way of life and a distinctive anatomy and physiology, so it is certain that the study opportunities in entomology will never be exhausted. With such a vast science it is vital that one specialize so as to be able to make a definite contribution. In most cases specializing in just one family of insects is too much for a lifetime. For example, if a person limits himself to a study of ants, the family Formicidae, he might be regarded as an extremely narrow specialist, yet the ants constitute a much larger field for research than many well-staffed sciences such as those relating to birds and mammals.

One's specialty usually begins because of some attractive feature of a group. Often the preference is based on unscientific reasons, such as the appeal of large size, bright colors, or the ease of getting started. As a result, certain insect groups such as butterflies and some beetle families have been very intensively studied while less spectacular, but equally interesting groups, are almost neglected. Before deciding on a specialty it is well, therefore, to investigate the opportunities. For all you know, you reside in an extensive region which has never had a resident specialist in some group of insects. Concentrated collecting and study of such insects would certainly lead to many exciting discoveries.

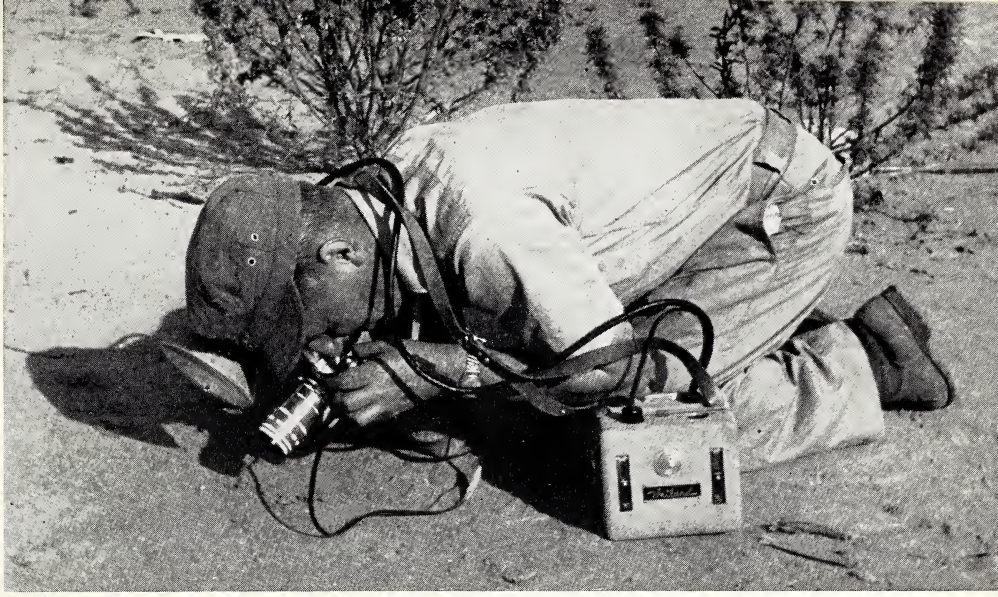
First of all, collect and identify as many local species as possible in your chosen specialty. Then your collecting trips should gradually be extended to include more and more life zones and faunal regions so as to enrich the collection. While all this is going on, start gathering a special library on the subject, starting with general works such as catalogs and monographs. Many of these are offered for sale by scientific book dealers. Most of the papers will have appeared in technical journals. As a rule it is unwise for an individual to purchase sets of these journals to gain access to the few papers he requires. Try to secure separates of these articles by purchase from a dealer or from the author if possible. Failing this, have the necessary pages microfilmed. This service is provided at a nominal cost by certain large libraries, such as that of the U.S. Department of Agriculture.

By watching the current periodicals and checking *Biological Abstracts,* or the Insecta portion of the *Zoological Record* (available by subscription or reference in large scientific libraries), one can keep up with recent literature and often locate and establish contact with other specialists. It is then possible to add to the completeness of a collection by exchanging.

Over a period of specializing you will begin to amass information that has not yet been made known. At this time you may begin to think of writing papers for scientific journals. Be very cautious at this stage and seek the advice of some advanced research worker to determine your fitness for the undertaking. For the average amateur a highly creditable objective could be the amassing of a fine collection with its accompanying biological data. The description of new species could be left to those who are able to do so in conjunction with revisions and monographs of high merit.*

It doesn't necessarily follow, however, that one must have a college degree in entomology to be qualified to publish. Some of the best work in science has been done by persons without any formal training. Far more important than mere exposure to a number of college courses is one's degree of curiosity, drive, and initiative. Even among professionals the most prolific workers are those who are motivated by the enthusiasm that characterizes the amateur.

* Expert guidance for collectors at this stage is to be had in the book, *Methods and Principles of Systematic Zoology,* cited in the book list.



Ridiculous postures are often assumed by the insect photographer. In this one the Exakta and Strobonar are being used to make wasp pictures (pages 40 and 41).

Close-up Nature Photography

Nature photography is one of the finest of outdoor hobbies. When the subject is animal, such photography requires stalking skill and patience far beyond that used by the killer-hunter armed with a gun, for you must close in on your quarry to bring it within lens range. Furthermore, you are never restricted by closed seasons and are welcome to go into places that are out-of-bounds to the usual hunter.

Wild life is so abundant, varied, and little known—especially as we adjust our perspective to include insects and other small creatures—that there is always a good chance of catching a species on film for the first time, or of portraying it in a manner superior to all previous attempts.

Added to all this is suspense. Nature photography is a real game of chance. When we set out for a day of it, we do not know when, where, or what we will encounter. Then after the field work is done, there is still the suspense of not knowing until the film is processed just how well, if at all, our efforts have succeeded. The disappointments and failures that inevitably come make the successes we do achieve all the more gratifying.

The pictures presented in this book are only a few of the many I have taken of small animals during the past two years. I would like to pass along a few things I have learned about the necessary equipment and the technique involved, for I want others to join me in the pleasures and sport I have experienced.

The success of our animal photography, as in any other skill, is a reflection of the quality of the equipment and the kind of standards we set up. These standards are easy to state, but not always so easy to attain. The ideal is simply a clear picture of an undisturbed animal doing some interesting, normal thing.

Nature Faking

After many exasperating failures to get a picture of some active or elusive insect, the temptation to nature fake is certain to beckon. The worst form of this is to catch and kill the subject, then photograph it posed in what is hoped will appear to be a life-like posture. The next worst form is to place the too active animal in the refrigerator or in a portable icebox until it is numbed into inactivity. The skill required to photograph dead or immobilized animals is no greater than that needed to copy a picture in a book, yet much of what has been written about insects is illustrated with just such pictures.

Another deplorable form of nature faking is the photographing of animals in staged combat or in other unnatural situations. Whenever possible one should try to make candid pictures. Nature's truths are always stranger than fiction.

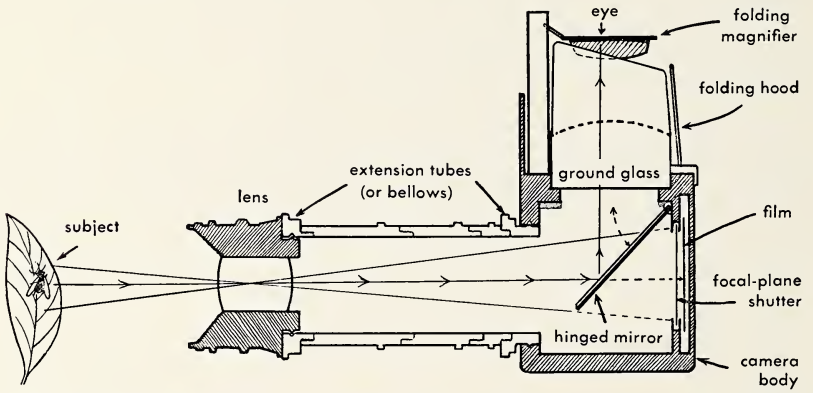


Diagram of the structure of a single-lens reflex camera. This type of camera is the key to successful close-up photography of small active animals.

Cameras and Equipment

It must be realized at the outset that good candid insect photography requires high-grade precision instruments. Fortunately the cameras involved can be used for all sorts of general photography as well as close-ups. In selecting a camera for candid close-up nature photography the main point to keep in mind is that it should be of the type that enables one to quickly view and sharply focus the subject through the picture-taking lens. This is made possible by means of a hinged 45° mirror between the film and lens that reflects the picture image on a ground glass. This mirror snaps out of the way an instant before the exposure is made. Cameras of this type are called single-lens reflex cameras, and there are quite a number of different makes on the market in a wide range of prices.

There are also double-lens reflex types, but these can be used only for fairly large subjects at a distance from the lens. The large number of

cameras having indirect view finders coupled to the lens are almost useless unless they can be converted by the use of a reflex housing between the lens and camera body. Some of these cameras can also be adapted by use of special focusing backs, but most insects will not wait for the photographer to make the necessary preparation. Many fine insect pictures can be taken with the standard view cameras, but the subjects must be fairly stationary.

The majority of single-lens reflex cameras are miniatures using 35-mm. film or the two-and-a-quarter-inch square size. Larger negatives than these are unnecessary in this day of fine-grain development. Besides, if you can fill a frame of either of these sizes with the enlarged image of a tiny insect, you are probably reaching the limit of the resolving power of the lens or, in any event, are running into serious depth-of-focus problems.

Another element is film cost. With so many unpredictable or uncontrollable factors, such as movement of the subject, bad posture and lighting, and confused backgrounds, it is necessary to take many pictures in order to get a few good ones. The low cost of the 35-mm. and the two-and-a-quarter-inch film is therefore a decided advantage.

The 35-mm. single-lens reflex camera I am using is the Exakta VX. The availability of a bellows extension and the simplicity of this camera's adaptation to the microscope render it particularly useful for photographing small objects in nature.

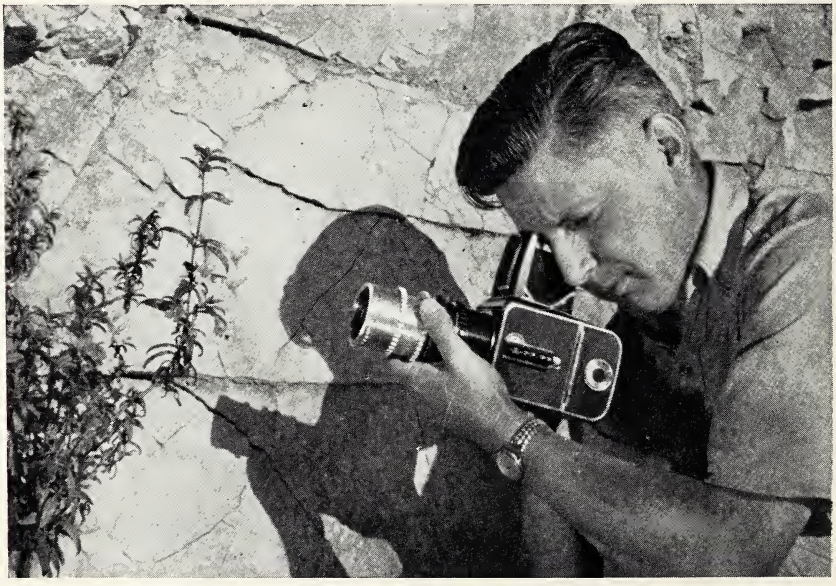
In the two-and-a-quarter-inch size my work is being done with the Hasselblad manufactured in Sweden. This film size is particularly useful for photographing insects of moderate size, especially those whose image would have to be reduced to fit within a 35-mm. frame. It can also be readily adapted to high magnification work. Unfortunately, I have had my Hasselblad only a short time and cannot present at this time the wide selection of pictures that has been possible with the Exakta.

The lenses that come with these cameras are excellent, but in both cases an instrument shop can produce threaded rings that make possible the use of special photomacrographic lenses such as the microtessars. Because focusing of a single-lens reflex camera is always done through whatever lens is attached, no special focusing accessories are needed in making such conversions.

In addition to a reflex camera, a set of extension tubes or a bellows extension is needed to increase the image size of the subject. Beyond this, all that one needs is a tripod and cable release. I recommend a stubby type of tripod with a crank-operated elevator for quickly changing the height of the camera.

Freehand Photography

I use this phrase for photography in which the camera is held in the hands, not on a tripod. The camera is merely made ready with extension tubes of a length appropriate for the anticipated subject. Then you walk along out-of-doors scanning the flowers, foliage, and ground for something you want to shoot. When you sight a subject, set your shutter and lens aperture and slowly approach it. You will soon discover that insects are disturbed less by slow movements than by sudden ones. When within the focusing range, locate the subject on the camera's ground glass and approach it until it comes into focus. A press of the shutter button and the picture is made. Most likely, however, the insect will have flown away long before this, but that is just part of the game. Keep trying; your success will be closely related to your patience, opportunities, and temper control.



Usually small animals will not wait for the photographer to set up his equipment on a tripod. One must be able to approach, as shown by the Hasselblad, with the camera held in the hands. Focusing is accomplished by moving the whole camera.

The shutter speed and lens aperture will have to be adjusted in accordance to the length of the extension tubes used. There are formulae for this, but I prefer to rely on experience based on a period of trial and error. For example, in bright sunlight I have found that f/11 at a 50th of a second is a good basic exposure when extension tubes that double the focal length of a 50-mm. lens are used. These figures are for use with Plus X film.

Upon examining your negatives you soon become aware of certain problems involved with freehand nature photography. First, you may not be able clearly to see the subject against most natural backgrounds, for these are usually confused patches of light and shadow. This can be corrected only by experience that will tell you when the background is simple enough to warrant an exposure. Learn not to be misled by contrasting color of the subject and background when working with black-and-white film. The next problem is fuzziness of the image. I check negatives for this with a 10X hand lens before deciding which ones are worth keeping and printing. Fuzziness may be due to faulty focusing, movement of the subject by wind or otherwise, and, most of all, camera movement. The need for steady hands cannot be overemphasized. When working near the ground use your elbows for steadiness, and at times brace the camera against a neighboring object or the ground.

Flash Photography

Anything that makes possible stopping the lens down to finer apertures to get increased depth of focus, and at the same time permits shortening the exposure time, will solve many of the problems just mentioned. Synchronized flash is the answer, and it will be noted that most of my work is now dependent on this. Flash bulbs may be used, but if one is going to do extensive work, I strongly recommend portable electronic flash for economy and other advantages. Most of my pictures have been taken with the Heiland Strobonar IA.

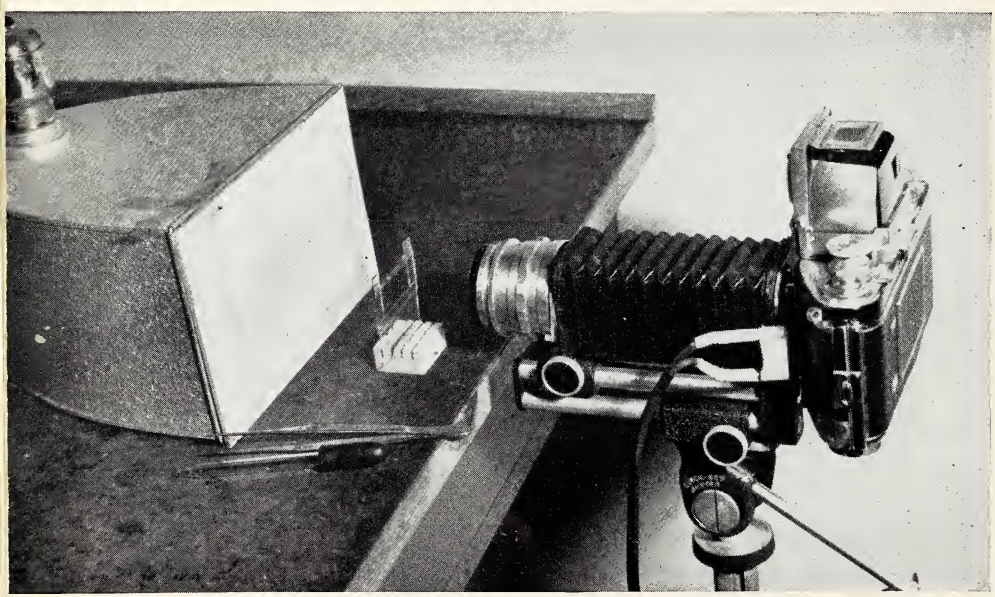
Flash tends to standardize the light factor, and most exposures can be made at very small lens apertures, usually f/22. The light is held quite close to the subject. Experience alone will tell you just what distance and angle will produce the right exposure and cast good light on the particular subject. I use flash not only to stop action but for stationary subjects as well. It completely eliminates the hazard of camera and subject vibration.

Color Close-ups

Although good color close-ups can be made in natural light, the percentage of success is greatly increased by the use of electronic flash. I have found that this flash is very similar to daylight and can be freely used indoors. The problems of color values inevitably increase in close-ups, however, because of the great differences in tone that may occur side by side in small environments. Thus, for example, a yellow butterfly may be greatly over-exposed while the blue flower it sits on will be just right. In spite of all, it is possible to make many thrilling color pictures of insects with the equipment mentioned above. The value of the successes far offsets the failures.

Close-up Photography in the Studio

Many small insects, such as aphis and micro-aquarium subjects (p. 56), requiring high magnification, are best photographed at home from a tripod and with artificial background and lighting. Many of the more sluggish insects can also be photographed best if brought in alive from the field and handled under controlled conditions. I don't regard this as a sporting type of nature photography, but it often results in most useful pictures. In comparison with these sure-fire studio shots, pictures such as that of the alert tiger beetle shown on page 30, the one successful shot out of more than fifty vain attempts while crawling on hands and knees, gives me real satisfaction. It is a trophy of the chase far more creditable and unusual than the dust-gathering, stuffed creatures that hang over the mantles of hunting lodges.



Many insects can be photographed in the laboratory. For high magnification work, wherein critical focusing is required, this is almost a necessity.

The above picture shows the Exakta and Novoflex bellows focused on mosquito larvae in a micro-aquarium (see p. 56). This aquarium is made of square microscope coverslips glued in place with colorless fingernail polish. Back lighting with an old enlarger head gives translucency while front lighting with electronic flash stops action and enables the use of a small lens aperture.

Additional Reading

35 mm Photography with an Exakta, by K. L. Allinson, The Fountain Press, London (in U.S.A. and Canada: Exakta Publications, 46 West 29th St., New York, N.Y.).

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